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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN, THE NATIONAL IRONFOUNDING EMPLOYERS' FEDERATION, THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

SEPTEMBER 10-16.
International Foundry Congress:—International Foundry Congress at Prague.

SEPTEMBER 18-21.
Institute of Metals:—Silver Jubilee Autumn Meeting in Birmingham.

A Legitimate Grouse.

One of the last jobs which occupied our attention before we assumed this chair was the starting up of an electric furnace somewhere in France. The material for the plant had been shipped by Calais, Bordeaux and Genoa, with the result we were cooling our heels on the slopes of the Alps for three months instead of three weeks. This fact indicated to the buyer that the plant had not been erected before despatch.

Generally speaking, in the provision of complicated foundry plant, the suppliers do not make every detail themselves. The electric motors, switchgear, reduction gearing, the castings, are usually made by specialist firms and are delivered direct to the ultimate user. This, of course, saves carriage, but delays and inconveniences resulting therefrom have convinced us of the necessity of making a complete assembly of the plant at the factory of the supplier. This may cost money, but speaking with a vast amount of personal experience, supplemented by many conversations with innumerable foundry owners, we are prepared to state that this is a type of service for which the consumer is only too happy to pay. A charge which should be included in the tender to our mind is that of supervision for the starting up and working of the plant, but it should be a separate charge at a fixed sum per diem. This is of real advantage to both parties, as neither the buyer nor seller ever feels under any special obligation. It gives the purchaser the benefit of seeing his new plant working under production conditions with expert supervision and the designers an opportunity of obtaining reliable performance data first hand. Personal experience has also shown that it is materially advantageous for the seller's expert to start up the plant and return again after a month or so and to spend a few more hours or days at the buyer's works. Any little difficulties and snags can be discussed and remedied, whilst operating costs can be analysed and possibly production can be speeded up. There is some adage which, if our memory serves us correctly, postulates "Well begun, half done." In no walk of life does this apply with greater force than in the supply of foundry equipment, because, after all, foundries are not engineering shops, and extra help is demanded from the suppliers.

Cast Failures.

Designers have come to regard the annual technical report of the British Engine Boiler and Electrical Insurance Company as a valuable and impartial summary of plant failures, such as come under the notice of its engineers and inspectors. The report for 1932 just issued is no exception. The interesting announcement is made in it of the absorption of the Manchester Steam Users' Association, founded in 1854, and the precursor of all subsequent bodies of this type.

The report is, of course, mainly concerned with failures of wrought metals, and much attention has been given to welding problems. It is pointed out that metallurgical soundness is of the greatest importance in ensuring good life. If, however, the part in question is submitted to a low stress a defect may have little or no significance, and may indeed only be discovered after years of satisfactory service, or indeed not at all. It is estimated that not more than 10 per cent. of the breakdowns experienced by the company are due to mechanical cause.

In examining the report we naturally looked for references to failures of cast structures, either iron, steel, or non-ferrous metals. An interesting account is given of the destructive failure of one of four cast steel autoclaves, working at 650 lbs. per sq. in. There was no evidence that any of the cracks found after the failure existed prior to the explosion, nor had any been discovered on previous inspection, neither could it be concluded that the trouble was due to weakness of the cover. It was not possible to blame the casting in any way, and an abnormal rise in pressure was considered the most likely cause.

For records of cast-iron failures it is necessary to examine the synopsis of Board of Trade reports on explosions during 1931 under the Boiler Explosions Acts, in which some fifty reports are summarised. These include cast-iron steam pipes, jacketed pans, sectional boilers, valve chests, radiators, hot plates, calendars, stop valves, etc. The worst case, involving loss of life, was that of a fuel economiser in a woollen mill. We take this opportunity of expressing our appreciation of the care with which the report is prepared, and its value to the industry.

C

Iron and Steel Institute.

AUTUMN MEETING.

The autumn meeting of the Institute will be held at Sheffield on September 12-15, under the presidency of Mr. W. R. Lysaght, C.B.E. We append particulars of the arrangements.

For each member and lady taking part in the visits to works and/or social entertainments, a fee of 10s. 6d. (2s. 6d. in the case of associates) will be charged. The fee will not be payable by members who attend the technical sessions only.

Programme.

Tuesday, September 12.

2.30 to 6 p.m.—The Hon. Secretary's Office at the University, St. George's Square, will be open for the registration of members and their addresses, and for the distribution of programmes, badges and tickets.

8 to 11 p.m.—A Reception will be held by the University of Sheffield, at the Department of Applied Science, St. George's Square. The Department of Metallurgy will be open for inspection.

Wednesday, September 13.

10 a.m.—General meeting in the Mappin Hall, the University, St. George's Square. A welcome will be extended to the Institute by the Lord Mayor of Sheffield (Alderman Ernest Wilson) and by the Vice-Chancellor of the University of Sheffield (Dr. A. W. Pickard-Cambridge, M.A.).

1 p.m.—Members and their ladies will be entertained to luncheon at the Royal Victoria Hotel by the industrialists of Sheffield.

2.15 p.m.—Visits will be paid to the works of the following firms:—The English Steel Corporation, Limited; Messrs. Steel, Peech & Tozer, Limited; the Staveley Coal & Iron Company, Limited; the Corporation Electric Power Station; Messrs. Brown Bayley's Steel Works, Limited; the Sheffield Coal Company, Limited, Birley; Messrs. Darwins, Limited; Messrs. B. Huntsman & Company, Limited; Messrs. Walker & Hall, Limited (Silversmiths and Cutlers); Messrs. Markham & Company, Limited, Chesterfield.

Members can visit one works only during the afternoon. Tea will be provided at the works.

Ladies' Programme.—The ladies will be conveyed by motor-coaches through the beauty spots of Derbyshire. Tea will be provided *en route*.

8 p.m. to 1 a.m.—A reception and dance will be given by the Lord Mayor and Corporation of the City of Sheffield at the Town Hall.

Thursday, September 14.

10 a.m.—General meeting in the Mappin Hall, the University, St. George's Square.

1 p.m.—Members and their ladies will be entertained to luncheon at the Royal Victoria Hotel by the industrialists of Sheffield.

2.15 p.m.—Visits will be paid to the works of the following firms:—Messrs. Thos. Firth & John Brown, Limited; Messrs. Hadfields, Limited; the Park Gate Iron & Steel Company, Limited; Messrs. T. W. Ward, Limited; the Sheffield Gas Company, Limited; Messrs. S. Osborn & Company, Limited; Messrs. Viners, Limited (Silversmiths and Cutlers); Low-Temperature Carbonisation, Limited; Messrs. Jas. Neill & Company, Limited. Arrangements will be made to take a limited number of members round the corrosion field of the Corrosion Research Committee, if desired.

3 p.m.—*Ladies' Programme.*—The ladies will be received by the Lady Mayoress of Sheffield (Mrs. Ernest Wilson) at the City Hall.

7.30 p.m. to 1 a.m.—Members and their ladies will be entertained at a banquet in the Cutlers' Hall by the industrialists of Sheffield, which will be followed by a dance.

Friday, September 15.

9 a.m.—Members and their ladies will leave Sheffield (L.N.E. Railway Station) for Scunthorpe by special train.

Visits will be paid to the works of the following firms:—Messrs. John Lysaght, Limited (Normanby Park Works); the Frodingham Iron & Steel Company, Limited; the Appleby Iron Company, Limited; the Redbourne Hill Works (Messrs. Richard Thomas & Company, Limited); the Scunthorpe Steel Foundry (Messrs. Thos. Firth & John Brown, Limited).

Members and their ladies will be entertained to luncheon by the industrialists of Scunthorpe.

Members' Mail.—Members' mail may be addressed to them "C/o The Iron and Steel Institute, The University, St. George's Square, Sheffield."

The Hon. Secretary's office will be open on the Wednesday and Thursday from 9 a.m. to 12 noon.

List of Papers.

The following is the complete list of Papers to be submitted at the meeting:—

(1) "Fifth Report on the Heterogeneity of Steel Ingots." By a Joint Committee of the Iron and Steel Institute and the National Federation of Iron and Steel Manufacturers. (Special Report No. 4. Copies will be supplied only on request. The Report will not be reprinted after the meeting.)

(2) J. H. Andrew and J. B. Peile: "The Effect of Tin as an Impurity in Mild Steel."

(3) W. B. Baxter: "Notes on the Utilisation of Blast-Furnace Gas."

(4) W. J. Brooke: "Heat Conservation at the Normanby Park Steel Works, Scunthorpe."

(5) J. H. S. Dickenson and W. H. Hatfield: "The Influence of Beryllium on Steel."

(6) J. W. Donaldson: "The Thermal Conductivity of Wrought Iron, Steel, Malleable Cast Iron and Cast Iron."

(7) M. L. V. Gayler: "Alloys of Iron Research. Part XI.—The Constitution of the Alloys of Iron and Manganese."

(8) J. E. Hurst: "Some Experiments on the Resistance to Wear of Nitrogen-Hardened Cast Iron."

(9) N. P. Inglis and W. Andrews: "The Effect on Various Steels of Hydrogen at High Pressures and Temperatures."

(10) F. Lloyd and R. V. Wheeler: "A Coke-Fired Reheating Furnace."

(11) R. A. Mott and R. V. Wheeler: "Improving the Coking Performance of Weakly-Caking Coals."

(12) S. H. Rees: "Some Properties of Cold-Worked Sorbitic and Austenitic Alloy Steel Wire."

(13) A. Robinson: "Some Factors Leading to Greater Production from a Steel Furnace."

(14) I. G. Slater: "The Effects of Pickling on the Properties of Carbon Steels."

(15) F. C. Thompson: "A Note on the Effect of a Backward Pull upon the Tension Required to Draw Wire."

(16) R. Treje and C. Benedicks: "A Method for the Electrolytic Extraction of Slag from Iron and Carbon Steel."

It is expected that, subject to the direction of the President, the following Papers will be presented for discussion in the order indicated:—

Wednesday, September 13.—Nos. (4), (3), (13), (2); and on

Thursday, September 14.—Nos. (1), (5), (7), (10), (8).

Deep Etching for Tool-Steel Testing.—In the "Transactions of the American Society of Steel Treatment," J. P. Gill and H. G. Johnstin describe experimental work for determining the best etching medium for tool steels. The action of the ordinary mineral acids was studied, and the properties of various steels estimated by deep etching. By dissolving a high-speed steel containing 0.7 per cent. C, 17.5 per cent. Co, 4 per cent. Cr and 1 per cent. V, a residue is obtained with a composition approximating to Fe_4W_2C, where part of the Fe may be replaced by Co or V.

District Presidents.—No. 2.

INSTITUTE OF BRITISH FOUNDRYMEN, LONDON BRANCH.

Mr. C. Howell Kain, who assumed office last January owing to the death of Mr. H. G. Sommerfield, is assistant foundry manager to Messrs. Lake & Elliot, of Braintree, where steel castings are made from arc and high-frequency electric furnaces; malleable iron castings from the electric furnace and high-duty iron castings from the electric furnace and cupola. Mr. Kain received his early training at the Technical School, Preston, and Manchester University. He also found time to serve a regular apprenticeship in the foundry of the English Electric Company, Limited. Later he had experience in a number of other Lancashire foundries, engineering shops

Mr. C. Howell Kain.

and constructional steelworks. He joined the Institute in 1927, has served on the Council since 1930, and is also a member of the Malleable and Melting Furnaces Sub-Committees. He has read Papers before the London, Preston and Middlesbrough Branches of the Institute, and this year is responsible for the official Exchange Paper to be read at the forthcoming International Conference to be held at Prague.

He also holds membership in the Iron and Steel Institute, Institute of Metals, and the Funf Club.

Iron and Steel Output in July.

The National Federation of Iron and Steel Manufacturers state that there were 69 furnaces in blast at the end of July, four furnaces having been damped down due to the Scottish holidays, one furnace having gone out of operation, and two furnaces commenced during the month. The production of pig-iron in July amounted to 343,900 tons compared with 345,600 tons in June and 292,600 tons in July, 1932. The production includes 89,800 tons of hematite, 159,400 tons of basic, 72,900 tons of foundry and 13,200 tons of forge pig-iron. The output of steel ingots and castings in July amounted to 567,500 tons, compared with 568,800 tons in June and 438,400 tons in July, 1932.

Coking Practice in the South Wales District.*

By W. R. D. Jones, D.Sc.†

The last time the Annual Convention was held at Cardiff, a review of the coking practice in the South Wales District was prepared by Dr. R. H. Greaves, M.B.E., Director of Research, Royal Arsenal, Woolwich, who was at that time a member of the staff of the Department of Metallurgy, University College, Cardiff. This present review is intended primarily to indicate progress and development since 1912.

The present conditions of trade in the steel, iron and foundry industries are reflected in the position of the coking industry. South Wales has experienced a most severe time, which fortunately seems to be improving. An examination of the figures given in Table I will indicate the present position. It is reasonable to assume that the returns for 1929 are the level of output which would normally be expected without the disturbing influence of the abnormal conditions of the war and immediate post-war years.

Foundry cokes should be dense and strong—not merely hard, because some hard cokes are very friable and easily fracture into very small pieces when the charge of iron is thrown on it in the cupola. It should "bear the burden," which means that when it gets down to the melting zone there should be enough "size" in it to melt the iron, and the coke should not burn away rapidly before melting is complete. The size of the coke should be regulated to suit the diameter of the cupola, using large-sized coke for a large-sized cupola. These factors cannot be specified rigidly, since difficult tests are required for the assessment of these values, but they are operative in the reputation which different foundry cokes possess, and in this respect the South Wales cokes show to great advantage. Other factors which foundry cokes should meet are:—(1) A low moisture content, as this acts as a carbon diluent. Mechanically-held moisture should be avoided by proper storage of the coke so that it is not exposed to rain. A moisture-laden coke (or blast) will lower the thermal efficiency of the reactions taking place in the cupola. (2) The ash should not exceed 10 per cent. and preferably 8 per cent. Apart from lowering the general efficiency of melting, excessive ash will smother the carbon particles of the coke and prevent proper combustion. (3) The sulphur should be less than 1 per cent.—the lower the better, as the sulphur in the coke passes, to a considerable extent, into the metal. A high-sulphur "pick up" will ruin the best metal and cause brittle castings. As regards foundry coke, the amount of phosphorus is not harmful, as so little is present in average-quality coke, and the "pick up" of about 0.02 per cent. does not seem to be much affected by reasonable variations in the phosphorus content of the coke. Generally speaking, South Wales cokes are comparatively high in phosphorus, averaging 0.04 per cent. (0.02 per cent. in good coke, 0.06 per cent. in coke of inferior quality).

South Wales coke manufacturers have kept pace with modern developments and requirements, with the result that it still provides, as it did in 1912, coke specially suitable for foundry work which is not surpassed in the whole country.

In Table II is a list of the coke-oven plants erected since 1912. It can be seen that since 1912 all the new ovens erected are of the by-product type. There are, however, still working more than 100 ovens manufacturing "beehive" coke in the Welsh rectangular ovens. The waste-heat ovens have been replaced with the regenerative type, while no "waste-heat" ovens have been built. The spare gas (probably about 50 per cent. in the case of the former as against 20 to 30 per cent. from the waste-heat oven), forms a useful factor in the plant economics. Developments in practice since 1912 are summarised in the following statements:—

TABLE I.—*The Position of South Wales in relation to the National Aspect of Coke, Pig-Iron and Steel Production.*

	1913.	1928.	1929.	1930.	1931.	1932.
Coke sold at coke ovens in—						
Great Britain .. .. tons	—	11,845,210	13,421,998	11,514,201	8,470,209	—
S. Wales and Mon .. .. ,,	—	1,344,020	1,690,193	1,181,674	702,174	—
Production of pig-iron in—						
Great Britain .. .. ,,	10,260,300	6,611,000	7,580,000	6,197,000	3,758,000	3,553,000
S. Wales and Mon .. .. ,,	889,200	841,600	929,000	539,800	279,800	354,100
Production of steel in—						
Great Britain .. .. ,,	7,663,876	8,520,000	9,655,000	7,298,000	5,179,000	5,276,000
S. Wales and Mon .. .. ,,	1,807,000	2,156,900	2,353,800	1,503,000	1,274,000	1,350,500
Average monthly No. and kind of ovens in use in Great Britain—						
Beehive	13,167	1,606	1,401	1,153	768	—
By-product	7,839	7,434	7,860	7,003	5,263	—
Other kinds		261	278	212	190	—
Total	21,006	9,311	9,539	8,368	6,221	—
Average monthly No. and kind of ovens in use in S. Wales and Mon—						
Beehive	305	106	107	108	101	—
By-product	1,151	810	895	706	429	—
Other kinds		261	278	212	190	—
Total	1,456	1,177	1,280	1,026	720	—

These figures not available until September.

Size and Capacity of Ovens.

There has been a general increase in the dimensions of the ovens:—

	Older ovens.	Modern ovens.
Capacity per oven ..	7 tons	15–16 tons.
Length (approx.) ..	30 ft.	40 ft.
Height (approx.) ..	6 ft. 6 in.	12 ft. 6 in.

The width and height of the oven are very important factors. The former has a direct bearing on the size of the coke produced, which is governed by the rate of heat transfer—small "fingery" coke being produced in the narrow (14-in.) oven. In the case of the wider ovens there is a tendency for the coke to be large-sized and "blocky." A further factor in this direction is the carbonising temperature. A narrower oven can be worked to give "blocky" coke if the prevailing temperature be lower than the usual (1,050 against 1,300 deg. C.). Before and during the early war period, the average width was about 22 in. The generally-accepted average in the modern oven is 18 in. On narrowing the oven, the throughput is increased and the coke structure is improved, until a width of about 18 in. is reached, below which the longitudinal and cross-fracture becomes accentuated and the coke produced is of smaller size, with the result that its market value for foundry purposes is diminished. Both the height and the width of the oven affect the uniform heating from top to bottom, which is essential for obtaining maximum coke yield and the best coke structure. To improve the operation of the ovens, many intricate designs have appeared of recent years to tax the skill of the brickmaker. To-day, however, a large number of the technical difficulties have been overcome, resulting in a simplification of design. Perhaps the chief difference between ovens of various design is the position and arrangement of the flues. All the new ovens erected in South Wales since 1912 have vertical flues in the side walls.

Refractories.

The life and service of a battery of coke ovens is dependent almost entirely on the refractory lining. The prevailing conditions in the oven are:—(1) A high temperature, actually in modern practice about 1,300 deg. C.; (2) a reducing atmosphere, so that if any iron oxide is present it will be generally in the ferrous condition and will form with silica, a low-melting and very fluid slag known as "scouring slag" ($FeSiO_3$), and (3) dependent on the nature of the coal being coked—the presence of sulphides or chlorides have a fluxing action on the lining.

The refractory brick lining has therefore to withstand severe service:—(1) A high temperature which is maintained steadily for a long time; (2) the flame action which is of a reducing nature, and has a fluxing action due to small particles being carried mechanically and probably concentrated at one point, and which also has a scouring and cutting action, and (3) sudden and extreme temperature variations which, in the old beehive or rectangular ovens is caused by quenching inside the oven, and which in the modern by-product oven, is due to the sudden inrush of cold air on opening the door to receive the ram. In addition it is necessary that the bricks should be strong to withstand transport and handling, and also that they should be uniform in shape with sharp clean edges so that the minimum of cement or jointing material is required.

The type of lining has changed in South Wales from fireclay bricks averaging 65 to 72 per cent. silica to the semi-silica with 78 to 80 per cent., and the present tendency is to replace the semi-silica with best silica bricks averaging 94 to 98 per cent. silica. When it is remembered that the life of the oven depends on its lining a cheaper first cost may be false economy. When the lining has to be renewed, not only is there no output of coke, but the by-product plant is idle. The advantages of the silica over the semi-silica lining are:—(1) Greater throughput as a result of the practicability of using higher temperatures; (2) greater throughput due to the higher "diffusivity," *i.e.*, the velocity with which temperature can be propagated, although the thermal conductivity of the two types is almost the same. As a consequence the same number of heat units will cause a greater increase of temperature in the same time in a wall of silica brick. It is realised that this factor is important in view of the nature of the coking operation. (3) Salty coals are not so deleterious on the silica linings. This is important in the South Wales district as the local bituminous coals contain an appreciable amount of sodium chloride and other salts which have a corrosive effect on the bricks. (4) It was feared that the greater tendency to "spall" due to the volume variations caused by crystallographic variations would detract from the value of silica bricks, especially when using a wet coal. This, however, has not proved to be the case, probably

* A Paper presented at the Cardiff Conference of the Institute of British Foundrymen.

† Dept. of Metallurgy, University College, Cardiff.

because by realising the liability of silica bricks to spall on extreme and sudden variations of temperature, the danger has been guarded against and avoided. That this is a real danger is shown in a recent personal communication from America. Information was given that a silica battery definitely cannot be shut down without very extensive cracking, and that some coke-oven managers were buying gas to keep their ovens hot whilst they were shut down. (5) One of the chief reasons for the replacement of fireclay and semi-silica bricks by silica bricks in coke-oven practice is the ability of the latter to carry heavy loads at very high temperatures, so that not only can higher working temperatures be used with impunity, but bigger and more robust plants can be erected.

The only serious disadvantage of silica over semi-silica bricks is the greater expansion of the former. This, however, can be minimised to some extent by efficient kiln practice in the manufacture of the silica brick, so that in service the permanent expansion will be small and take place so slowly that it can be easily accommodated. The temporary expansion will then be lower, and, with proper supervision, will be under control. A silica battery needs greater care in its preliminary heating, and a much longer time than that used with the fireclay or semi-silica lining is necessary before coking can begin. As a result of an extensive experience, the silica-brick lining is in almost universal use in American coke-oven practice. In South Wales, however, it is too soon yet to state definitely that the adoption of silica-brick construction is better than the older semi-silica from a working and an economic point of view. It is certainly a fact that the modern tendency is to use silica in all new constructions, and many plants in this country are relining their fireclay or semi-silica ovens with silica bricks.

TABLE II.—*Coke-Oven Plants erected in South Wales since* 1912.

Works.	Type of ovens.	No. of ovens.	By-products* recovered.	Remarks.
Glamorgan Coal Co., Llwynypia	Koppers regenerative	50	T, TP, S, G ..	Dismantled.
Great Western Colliery Co., Pontypridd	Otto regenerative ..	32	T, TP, S, BR, GTL..	Changed over from Otto waste heat in 1923.
Guest Keen & Nettlefold, Dowlais Merthyr	Otto regenerative ..	65	T, S, BC	Erected 1926, not working at present.
Guest Keen & Nettlefold, Cwmbran	Coppée waste heat ..	50	T, S, BC	Dismantled 1932 (erected 1906).
Powell Duffryn Steam Coal Co., Bargoed	Carl Still	50	T, TP, S, BR, GTL,	First silica brick ovens in Wales.
	Regenerator Still ..	36	Sulphuric acid ..	
Welsh Navigation Steam Colliery Co., Ltd., Coedely	Coppée regenerative ..	60	T, S, BR, concentrated liquor ammonia	—
British (Guest Keen Baldwin) Iron & Steel Co., Margam	Coppée regenerative ..	120	T, TP, S, BR, emulsions, varnishes, disinfectants	Restarted 1933, after prolonged stoppage.
Ebbw Vale Steel Iron & Coal Co.	Koppers regenerative	250	T, S, BR	Plant enlarged at various times.
North's Navigation Collieries, Tondu	Coppée regenerative ..	50	T, S, BC, GTL ..	Formerly 60 Coppée non-recovery ovens.
British Benzol & Coal Distillation Co., Ltd., Bedwas	Becker regenerative ..	35	T, TP, S, BR, emulsions	Most recent plant, started in 1929, still working.

* T = tar, TP = tar products, S = sulphate of ammonia, BR = rectified benzol, BC = crude benzol, G = Gas GTL = town lighting gas.

Mechanisation.

During the last 20 years the use of electric power in conveying and screening the coal and the coke, and in pushing the ovens, has developed considerably. The automatic "changing-over" machines which operate the gas valves and the air valves to the regenerators are worked by electric power. The results have been greater regularity of output, uniformity of the coke produced, heavy manual work has almost disappeared, and lower conversion costs.

Quenching.

A more careful quenching and efficient breeze removal has improved the quality of the coke. The old hand quenching at the oven mouth has been replaced by the use of the Darby quencher, which, in its turn, is being replaced by the electrically-operated coke-car with a central quenching station. There are not, as yet, any Sulzer quenching stations in South Wales. The latest method is the use of the coke-car into which the coke is pushed and conveyed rapidly to the central quenching station, where it is met with the requisite quantity of cold water from a tower immediately above the car. The quantity of quenching water is easily regulated, and the moisture content of the coke is under close control. It is always important to ensure that the quenching water operates at high pressure if the coke is to retain the minimum amount of water. The *appearance* of the coke depends to a large extent on the method and rapidity of quenching. The sooner the coke is quenched after "pushing" from the oven the better. The much-sought-after silvery-grey appearance has little connection with the performance of the coke in practice. Apart from the slight excess of moisture it contains—which is generally lost on the usual air drying which occurs during storage—the carbon contents of a dark and of a silvery coke are appreciably the same. The silvery-grey appearance is due to the deposition of graphitic carbon on the cell walls by thermal decomposition of the methane on its passage through the *already formed* coke structure. This lustrous appearance is readily lost by inefficient quenching and burning of the coke before quenching, *i.e.*, quenching too late, but the value of the coke is in no way impaired. Beehive coke which is generally quenched in the oven has a fine appearance, is massive, and is in great demand by foundry and blast-furnace managers, and commands an enhanced price. By-product coke, although possibly not of such a fine appearance, is, when properly graded, equally as good in every way, and its cost is much lower. In South Wales, beehive foundry coke is valued at 7s. to 10s. per ton more than furnace coke (which is generally by-product coke), whilst "special foundry coke" is at least 5s. per ton still higher. There must be some basis of quality underlying most of the reputations of well-known good foundry coke, for which users are willing to pay an enhanced price, and often a cupola which is "off" working can be brought back to its normal working by using certain brands of first-quality special coke. This, however, is possibly not because the special foundry coke is beehive, but because the manufacturers, by careful and controlled processing, have developed a uniform high-grade product which justifies the reputation. The Northern Coke Research Committee Report, 1926, 29, shows that, when made from the same coal, by-product coke is as effective as bee-hive coke for foundry purposes. The same report states that coke graded 2 to 3 in. in size was as satisfactory as ungraded (32 per cent. over 4-in.) coke.

Preparation of the Coal.

Rapid strides have been made in South Wales in the preparation and cleaning of coal for carbonisation. Wet and dry cleaning plants of improved design and efficiency have been erected with a consequent considerable decrease in the ash content of the coal delivered to the battery of coke ovens. The more efficient cleaning of the coal and the grading to exclude all particles above $\frac{3}{8}$ in. size have undoubtedly helped to improve the quality of the coke made in existing ovens. From 1927 to the end of 1931, although there was a large decrease in the output of coal, the quantity treated at washing and cleaning plants increased from 13.4 to 23.3 per cent. of the total output. Among the more representative of the coal-washing plants recently installed are those of the Powell Duffryn Company and the Ebbw Vale Company. The latter is the latest, and was erected at the South Celynen Collieries, Abercarn, and started working in 1932. It is an automatically-controlled jig-type wash-box, and is capable of washing and classifying 300 tons of raw coal per hr., varying in size from cobbles of 3½ in. to the finest duff, reducing the ash content approximately to the limit indicated by the washability curves of the various coals treated—the washing being conducted under strict laboratory control.

By-Product Recovery.

The striving for efficiency of recovering of by-products has resulted in improved technique in every department. Considerable advances have been made in the design of recovery plants, and such processes as heat transfer, still heating, benzol absorption, gas-cooling before the extraction of the by-products, ammonia absorption, and sulphate treatment. Perhaps the most significant advance since 1912 has been the development of benzol recovery, and the day is not far distant when home-produced motor spirit may be a very serious rival to imported spirit. Research conducted at the most recently-constructed plant in South Wales has resulted in a greatly increased yield of benzol of excellent quality at a much lower price.

The Bedwas Plant.

The latest plant erected in South Wales was constructed by the Woodall-Duckham Vertical Retort & Oven Construction Company (1920), Limited, for British Benzol & Coal Distillation, Limited, at Bedwas, near Cardiff and Newport. This plant, illustrated in Figs. 1-4, is amongst the latest six in the whole country, so that it represents up-to-date and modern design and operation. It embodies all the latest proved technical advances. The plant has been operated at throughputs ranging from 5 per cent. to 100 per cent. capacity without any difficulty being experienced. Equal attention has been paid to the design of the by-product recovery plant to secure the maximum yield of high-quality by-products, including sulphate of ammonia and motor spirit. The battery consists of 35 Becker cross regenerative combination ovens, heated by coke-oven gas. This is a vertical-flued oven with separate regenerators.

The heating system is unique, for by means of a cross-over flue the travel of the gases is short and the velocity is low. Burnt gases from the wide end of the oven always pre-heat the air from that side, and similarly for the narrow end, giving in this way a very uniform heat throughout the whole oven. Briefly, this is achieved in the following manner:—There is a series of vertical heating flues on each side of each oven. Two regenerators are built under each series of vertical flues. Air travels up the regenerators and meets with gas at the base of the vertical combustion flues, up which the gases travel in parallel. The products of combustion

are collected from each four or five vertical flues and are carried over the top of the ovens by means of the cross-over flues. There are six cross-over flues to each alternate oven. The intermediate ovens have no cross-over flues.

From the cross-over flues the waste gases are distributed into vertical flues exactly opposite the flues up which they have travelled on the other side of the oven. They travel down the vertical flues and are equally distributed in the two regenerators below. The heating gases in all the vertical flues on one side of an oven always travel in parallel flow, and there is no possibility of short-circuiting and consequent loss of efficiency. The ovens are 12 ft. 6 in. high, 40 ft. 8 in. long and of an average width of 18 in. The ovens and those parts of the regenerators which are subjected to high temperatures are constructed of silica bricks. The regenerator facings and oven tops are insulated, whilst the top of the ovens are covered with paving bricks.

The average capacity of the ovens is 16½ tons, and the battery has a carbonising capacity of 660 tons of coal per day, which is fed from a reinforced-concrete storage bin which will hold 1,300 tons. Individual inspection of each flue is provided for on the oven tops. Provision has been made for controlling the air inlet at the bottom of each regenerator and the rate of mixing gas and air in the vertical flues can be adjusted by means of two wedge-shaped bricks placed in each air-port. The coke-oven gas which is used for heating the ovens is conveyed from a gas-holder through the fuel-gas main and is recorded by an orifice-type meter with a capacity of 250,000 cub. ft. per hr.

Cleaning Plant.

The coal is cleaned by passing first through a Peale-Davis dry cleaner and thence to a Norton automatic wash-box, and when completely carbonised, is pushed out into a coke-quenching car.* The pusher machine is an ingenious contrivance which lifts the oven door, pushes the coke and levels the freshly-charged coal. It runs on a track in front of the oven and is controlled from an operator's cabin on the machine. The coke is pushed into a quenching car holding about 12 to 13 tons, and is taken by an electric locomotive to the central quenching tower made of brick. The quenching station is of the recirculating type. The quenching tank has a capacity of 10,000 gall. Two quenching-water pumps are provided for pumping water from the hot well to the quenching tank. Each pump has a capacity of 20,000 gall. per hr., and is automatically controlled, being governed by the level of water in the tank. A predetermined quantity of water is used in the quenching, after which the coke is conveyed to an inclined wharf where it is spread out and allowed to cool, and is then conveyed on a belt conveyor to a coke screen where the oversize or foundry coke is delivered to wagons and the undersize is further screened into three sizes.

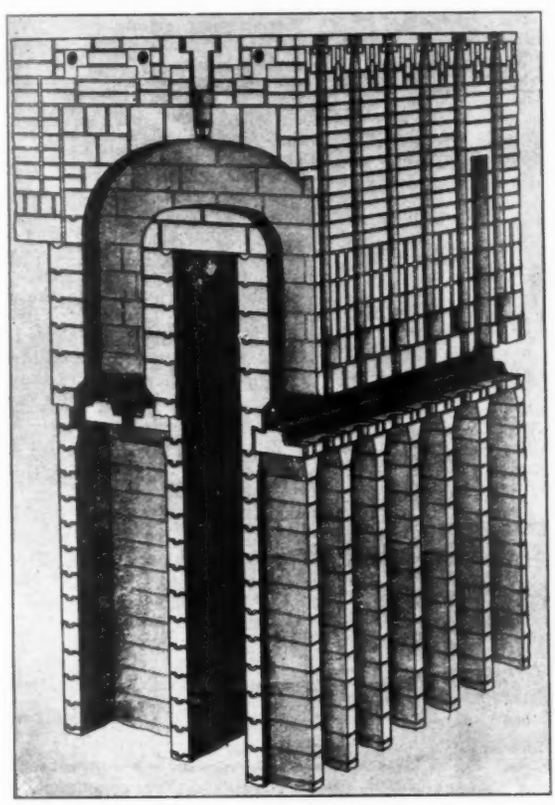

Fig. 1.—The Cross-over Flue in the Becker Oven.

* The middling and primary refuse from the Peale-Davis dry-cleaning table pass on to the Norton Tividale Automatic Wash-box. The coal recovered from this wash-box is de-watered and mixed with the cleaned coal from the dry-cleaning table.

The gas is conveyed from the oven off-takes through ascension pipes to the steel gas-collecting main. Liquor flushing sprays are installed in each ascension pipe, and in the collecting main at alternate ovens. The gas pressure in the collecting main is governed by a Shall Cross electrically-operated governor which controls a butterfly valve in the off-take main. The gas is exhausted from the ovens by a turbo-type direct-coupled high-speed exhauster, steam-turbine driven, and is passed to the by-product plant.

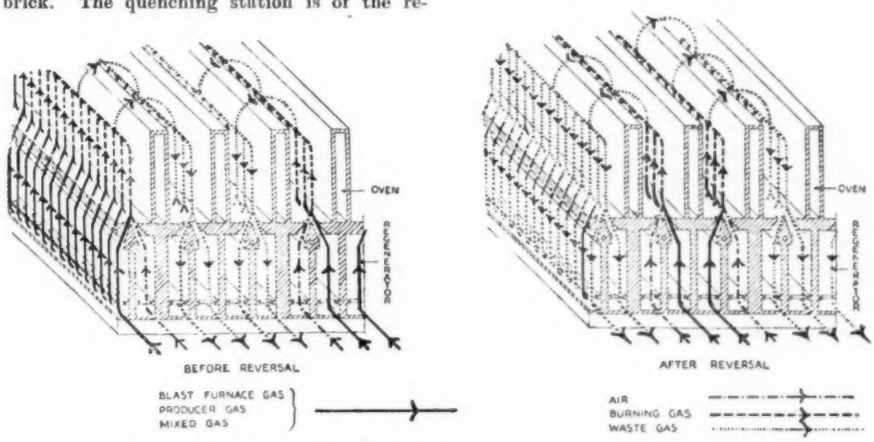

Fig. 2.—Diagram of the Flow of Gas and Air in the Becker Oven.

Ammonium-Sulphate Recovery.

The semi-direct method of ammonium-sulphate recovery is used, the tar being first abstracted. The dried ammonium sulphate produced is neutralised and delivered to store. From the sulphate saturator the gas passes to an acid separator, where any traces of saturator acid (sulphuric acid) are removed and it then passes on to the final cooler where the naphthalene is removed. The gas passes on to the two benzol scrubbers, and finally to the gas holder. One of the most important sections of the by-product works is the benzol house in which motor spirit is produced. The benzol scrubbers are 90 ft. high and packed with wooden hurdles. Benzol is scrubbed from the gas by descending streams of wash oil which, after being enriched, pass to a specially-designed cast-iron still. Here the benzol is driven off by steam distillation and the crude benzol is cooled and separated from the water which condenses with it. The crude benzol is refined and rectified in two stills, each of which is equipped with a dephlegmator, a cooler and a separator. Another important feature of this plant is the T.I.C. tar-distillation plant developed by the Woodall-Duckham Company. Molten lead is used as the heating medium for the tar undergoing distillation. The plant is designed to fractionate the tar into various portions from light oil to pitch. Road tar is also produced.

Character of the Coke.

Good foundry coke demands a strong structure, and in this respect the best Welsh coke cannot be surpassed. Its pores are small and finely divided, and in purity and freedom from deleterious substances it compared favourably in 1912 (and even more so to-day, with the modern developments which have taken place in South Wales) with cokes from other districts. It has proved itself eminently suited for the highest classes of foundry work. The necessary structure depends more on the type of coal coked than upon the method of carbonisation. Chemical analyses of the coal, although necessary as a criterion for purity, do not reveal these characteristics. It is necessary to test the coal by a small-scale coking test, such as the Lessing or the Gray-King assays, which have been developed to give direct information as to the

quality and quantity of the gaseous and liquid products of carbonisation, the rate of evolution of these products at different temperatures, and the influence of temperature and time of carbonisation on the qualities of the resulting coke. Another useful guide as to the value of a coal for coke-making is the Campredon test, which

Fig. 3.—Pusher Side of Battery, Bedwas.

will give what is known as the coking index or agglutinating value.* If the coal does not possess the requisite coking characteristics, improvements are often brought about either by blending various coals or by varying the coking practice, such as rate of heating, etc. Fortunately, the South Wales coking coals are eminently suitable for the production of the best-quality furnace coke without blending. The

Fig. 4.—Coke Side of Battery, showing Coke Car and Coke Wharf.

practice of blending the Welsh non-coking coals with coking coals in certain proportions dates back to a patent granted to J. P. Budd, of Swansea, in 1850, and although this practice was popular for producing certain types of coke, it has been given up for several years in the production of the best furnace coke.

* Complete details of these tests are given in the Official Publications of the Fuel Research Board of the Department of Scientific and Industrial Research.

Shatter Tests.

Apart from the usual laboratory chemical tests on coke, certain tests have become popular, as they reflect more closely the actual behaviour of the coke. Of these modern tests, the shatter test is considered to be the most useful, and has been standardised by the Midland Committee of the Coke Research Committee. The decrease in size of the coke during transport gives rise to small coke, and, to what is even more objectionable from the foundry point of view, non-uniformity. This test serves as a useful index to the power of the coke to withstand handling—the lower the shatter index, the poorer the quality of the coke. The test is carried out under standard conditions, and consists briefly of dropping 50 lbs. of the coke (of average and uniform size) from a height of 6 ft. on to a steel plate. This is repeated three times. The residue is sieved, and the percentages remaining on a 2-in. and a 1½-in. screen are called the 2-in. and 1½-in. shatter index respectively. The following figures are taken from an article by Mott in the Coke Oven Managers' Year Book, 1928:—

Origin.	Shatter index (2-in. screen).	Average for districts.
South Wales	93.9 88.2	91.0
Durham	79.7 73.2 65.0	72.6
S. Yorkshire	71.3 71.0 62.1 61.7	64.4
Derbyshire	45.1	45.1
Westphalian	88.7 88.1	88.4

The results of the shatter test are a useful guide, but a difference of less than 5 in the experimental determination of this shatter index on a 2-in. screen does not justify a differentiation between two cokes. It is possible also that a difference of five points may be insignificant in cokes of low shatter index, but the same difference between cokes of high shatter index may be important from the point of view of the cupola requirements.

Abrasion Tests.

Abrasion tests give some indication as to the ability of the coke to withstand attrition during transport in wagons, charging into the cupola or the weight of the burden. This test may be carried out in the following manner:—Varying amounts of coke are charged into a ball-mill which is rotated at about 20 r.p.m. for one hour. The coke is then sieved, and that passing through a 2-in. screen expressed as a percentage of the whole is taken as the index of abrasion. The indices for a series of foundry cokes are as follows:—South Wales, 8.0; Durham, 8 to 7.7; South Yorkshire, 6.7; Durham, 5.0; South Yorkshire, 4.8. There is no definite linear relation or conversion factor between the shatter and abrasion figures for any given coke, although a coke giving a good shatter index will generally give a good abrasion figure. Both the shatter and the abrasion tests serve as a useful control of the proportions of fines produced during handling and charging. Coke fines (not merely breeze) reduce the efficiency of the interaction between the components of the charge, and thus cause an increase in the coke consumption.

Examination of Ash Content.

A determination of the ash content of the coke and its nature seems to find favour among coke users. The ash in the coke is that obtained from the coal. By an efficient cleaning of the coal, that part of the ash which is not removable by washing (say, 6 per cent. in the coal to give 9 per cent. in the coke), does not seriously affect the structure and properties of the coke. That part of the ash which is removable in the washing operations, when left in the coal, acts as nuclei for longitudinal and transverse fractures, and so lowers the shatter and abrasion indices of the resulting coke. The ash is obtained by completely burning the powdered sample of coke until the residue is constant in weight. For commercial purposes the ash is usually accepted as a sufficiently accurate measure of the proportion of inorganic matter present. The three tests just given are such that any iron foundry can carry them out, and thus keep their coke supplies under control.

Calorific Value.

The calorific value of a coke is not often determined, and although the higher this value the

(*Concluded on page* 108.)

Cast Iron in Chemical Equipment.*

By Willard H. Rother.

(Metallurgist, Buffalo Foundry & Machine Company, Buffalo, New York.)

Modern metallurgical methods are producing cast iron of increased strength and improved physical properties such as high resistance to chemical corrosion, to pressure, and to deformation by heat. These new and improved characteristics have broadened the fields of application of cast iron in the process industries, and, where this knowledge has been intelligently applied, cost of production and maintenance has been reduced.

Properties governing the resistance to corrosion depend largely upon the chemical composition of the cast iron and may be regulated by altering the combination of elements in a given formula. Corrosive action during a given operation may also be materially influenced by changes in the chemical process itself. To obtain the best and maximum results in any given case, careful selection and adaptation of a proper composition of cast iron are therefore essential.

Important factors influencing the rate of corrosion by various chemicals are temperature, concentration of the chemical, working pressure, presence of air and moisture, and the formula and physical properties of the iron.

Cast iron has many important applications as an acid-resistant material provided proper consideration is given to the nature and the concentration of the acid. Resistance to the action of the weaker acids is pronounced, particularly at low or moderate concentrations. This resistance, which is ascribed to the formation of an iron-carbon-silicon alloy, in general decreases with increasing concentration, temperature, and pressure of solution.

Notwithstanding the extremely corrosive nature of the stronger acids, particularly acetic, hydrochloric, and nitric acid, cast-iron retorts are successfully used in the manufacture of these acids by the action of concentrated sulphuric acid on their respective salts. Presence of sulphuric acid completely modifies the corrosive conditions, as this acid has such a great affinity for moisture, that the part of the retort in direct contact with the acid is protected against attack. In view of the fact that the operating temperatures are above the boiling point of the acid produced, the top of the retort is in contact with vapours only. As long as surface condensation is prevented, no great corrosive action can take place and give trouble.

Ranges of Activity.

Sulphuric acid and phosphoric acid are exceptional in this respect in that an intermediate range of concentration exists in which these acids do not attack cast iron. The fact is well known that cast iron normally resists the action of sulphuric acid in concentrations ranging from 70 to 96 per cent.; at lower concentrations it is attacked, the most active range being below 20 per cent.; for sulphuric acid above 96 per cent. and for oleum, great care must be exercised in the use of cast iron because sufficient pressure may be created in the pores of the metal to cause a failure in its structure. In the same range of concentration mixtures of nitric and sulphuric acid are also safely handled in cast-iron equipment. Sulphonators, nitrators, concentrating pans, and acid recovery stills are built of cast iron of suitable grade and composition. Frequently corrosion of such equipment is accelerated by the presence of air, generally at the liquor level, both on account of its oxidising effect and its moisture content, which may locally reduce the concentration of the acid. This action of air is particularly to be guarded against when the equipment is left idle for any length of time, and the surface is left covered with a film of acid. Fatty-acid stills are also made of cast iron, as moisture has no influence in this case.

Alkaline Reactions.

For products with an alkaline and neutral reaction, the use of cast iron is unlimited; equipment such as reaction kettles, evaporator bodies, pumps, stills, fusion kettles, and filter presses is used extensively in the manufacture of ammonia, ammonium nitrate, aniline, calcium and magnesium chloride, ferrous sulphate, phenol, sodium chloride, sodium carbonate, sodium sulphide, caustic soda, and many dyestuff intermediates. It is to be noted that cast iron is resistant to the action of sulphur and sulphides and, in the absence of moisture, to gases such as chlorine and sulphur dioxide.

The resistance of cast iron to corrosion is in part due to the presence of substantial quantities of silicon and carbon, each of which characteristically resists the action of chemicals. Silicon forms a solid solution with the iron, while carbon is present in two forms, a smaller portion in combined state with the iron, and a larger portion in a free state as graphite. Accordingly when cast iron is subjected to a slight attack, by a corrosive medium, the iron portion is dissolved and a coating of free or graphitic carbon is left on its surface. To a certain extent this coating acts as an insulator against further attack of the corrosive medium; if allowed to remain as formed it prolongs the life of the cast iron. When acted upon by a corrosive agent which has an oxidising effect, silicon acts in a similar manner by forming a protective coating of silica on the surface of the cast iron.

Microstructure Favourable.

The microstructure of cast iron shows a matrix in which free graphite is more or less regularly distributed in the form of plates. When a casting is poured, graphite is largely in solution in the molten iron and separates out during the granulation period when crystallisation takes place. In accordance with the physical laws of crystallisation, grain structures of metals are controlled by the cooling rate of the metal, which, in turn, to a great extent, depends upon the size, thickness and volume of the casting. Therefore, the surface of the casting is of a finer structure than the interior, which, on account of its slower cooling rate, is coarser. In addition, an allotropic change in structure, involving the interior but not the exterior shape of the grains, occurs after solidification.

Excellent results have been attained in modern metallurgy by introducing various alloying elements into cast iron in order to increase its resistance to corrosion. The significant fact is that alloys can be so introduced without detracting from the casting properties of the iron. The increased resistance of cast iron to corrosion through proper alloying is attained by stabilising the grain structure of the metal whereby an improved form of graphite, more uniformly distributed, is obtained. Such irons, developed during the last few years, contain large quantities of copper, nickel and chromium. Their higher cost restricts their application to the more corrosive products, or to cases where even the slightest contamination with iron must be avoided. Such alloys are used to prevent discoloration in the manufacture of phenol, paints, pigments and foodstuffs, and to minimise catalytic action as, for example, the unfavourable influence of minute quantities of copper or iron on the rate of decomposition of butter-fat in milk powders.

Cast Iron and Steel Compared.

A comparison between cast iron and steel shows that the latter, although of greater strength than cast iron, is more limited in its application as a corrosion-resisting metal, at least in the chemical industry. This is primarily due to the fact that comparatively little carbon and silicon are present in steel. Whereas the inherently resistant properties of cast iron may be increased by the addition of small percentages of suitable metals, similar results are obtained with steel only by addition of such large quantities of alloying elements that the added cost and the increased difficulties in fabrication prevent general application.

Cast iron has greater resistance to erosion than most other metals. This is partly due to the nature of the common elements in cast iron, having regard not only to their chemical but also to their physical properties. Two conditions existing in the manufacture of cast iron serve to increase its resistance to erosion; first, the rapid cooling at the surface produces a dense, hard skin; secondly, silica sand in contact with the hot metal is burned into the surface of the cast iron. These factors tend to increase resistance to erosion as well as to corrosion.

Addition of alloying elements to cast iron also increases resistance to erosion. Equipment designed to resist erosion, as well as corrosion, should be constructed of a metal with maximum hardness, strength, rigidity and toughness, and these characteristics are most easily obtained by the use of suitable alloys. Alloy cast iron is desirable in equipment used in agitating corrosive liquors containing solids where the abrasive action is great. While fabricated metals are generally characterised by ductility, toughness and strength, they lack sufficient stiffness to withstand the abuse encountered in this type of equipment, and are therefore subject to distortion. Finally, special cast irons afford greater hardness when that characteristic is required. Modern metallurgy, with its thorough physical and chemical control and the use of new alloys, has enabled the foundryman to produce cast iron with any tensile strength up to 27 tons per sq. in.

Heat Resistance.

The ability of cast iron to resist the action of heat depends upon the stability of the carbides present in the iron. In ordinary iron the combined carbon is present as a simple iron carbide. On heating, these carbides decompose, forming graphite and iron. This is one of the causes of growth in ordinary cast iron. Stabilisation of the carbides in an iron may be effected by proper selection of alloying element. With good metallurgical control, a complex carbide is produced that is very difficult to break down.

The heat-resisting properties of cast iron are important in kettles which are heated by direct contact with flue or furnace gases, to temperatures of about red heat or above. At these temperatures the metal must retain sufficient strength to sustain the weight of the contents of the kettle. This application calls for metal which will resist the action of chemicals on the one side and flue gas of high temperatures on the other side—gases which may be either oxidising or reducing in nature. Frequently, faulty furnace construction allows the flame to impinge on the kettle. This condition should be avoided, because excessive oxidation and uneven heating cause accelerated action of the chemical on the metal, thus impairing the life of the casting. The metal must also be impervious to shock caused by sudden temperature changes. The grain structure should remain unaltered under variations in the operating conditions. Uniformity and stability of the grain structure is therefore of utmost importance.

Short time tensile tests were run at a temperature of 650 deg. C. to determine the properties of alloyed cast iron at elevated temperatures. These tests were conducted according to the procedure outlined by the American Society for

* From "Chemical & Metallurgical Engineering."

Testing Materials in their symposium in 1924. The following table shows the data obtained in these tests with values for steel and ordinary cast iron included for comparison. These values represent averages and not individual tests.

	Tensile strength at 650 deg. C.	Per cent. of strength retained.
Heat-resisting cast iron	7.9	56
High-test cast iron ..	6.5	30
Ordinary cast iron ..	5.5	40
Steel	1.7	5

"Per cent of strength retained" is calculated from strength of these materials at room temperature. The steel referred to is a low-carbon steel.

Construction Requirements.

When steel is used in construction, stresses below the yield point of the metal are the only ones allowable. A nickel-chromium steel of somewhat higher-carbon content showed a drop of 84 per cent. in the yield point at 650 deg. C. (37.0 tons down to 6.7 tons). The safe load for this steel at 650 deg. C. would probably not be over 4.4 tons per sq. in. This figure is considerably under the figure for the tensile strength of the heat-resisting cast iron. As the tensile strength and yield point of cast iron practically coincide, the tensile strength of the cast iron is directly comparable with the yield point in steel. At temperatures below 425 deg. C. cast iron retains the same strength that it has at room temperature.

Cast iron is favoured in many instances because of its reliability, and because it may be cast in a single piece, thereby eliminating joints which are a frequent source of trouble. Use of cast iron also eliminates the possibility of any galvanic action at the point of contact between different metals, or between a weld and the adjoining metal. Cast iron can be made up in such manner that the dimensions are sufficiently accurate to allow the use of close-fitting working parts, as for instance, kettles with close-fitting agitators.

The possibilities presented in regard to the use of cast iron in the process industries are by no means exhausted, for the inherent characteristics of cast iron lend themselves to such comprehensive and varied utilisation by modern metallurgical treatment that the field of general and special usefulness of cast iron in the chemical industry is becoming more and more extended.

Coking Practice in the South Wales District.

(*Concluded from page* 106.)

higher will be the calorific intensity or pyrometric heating effect, this factor depends so much on other factors that it has been accepted as a general rule that providing the coke passes the usual tests, then the calorific power can be left to itself. The determination is more difficult than in the case of the coal. The calorific intensity, although intimately connected with the calorific value of the coke is also influenced by other factors such as, possibly, combustibility and reactivity. Further, the temperature in the melting zone is also dependent on the proportion of coke in the burden, and on the skill of the cupola man. A growing need for a knowledge of the calorific value of coke is apparent. There are conflicting views concerning the effect of combustibility and reactivity of the burning properties of the coke, and it is out of place to discuss them in this Paper.

In conclusion the writer wishes to thank Mr. A. E. Taylor, B.Sc., A.I.C., for much valuable information.

Precipitation-Hardening of Copper Steels.

INFLUENCE OF VARYING HEAT TREATMENT.

Before a meeting of the American Institute of Mining and Metallurgical Engineers in May, Messrs. Cyril Stanley Smith and Earl W. Palmer read a Paper entitled "The Precipitation-Hardening of Copper Steels," in which they stated that they were concerned especially with the precipitation-hardening of copper steels, and realising that an important future for these steels depends largely on the more or less unique property of precipitation-hardening, the authors made a detailed study of the phenomenon and its dependence on variations of treatment and composition. Most of the work described in the present Paper is limited to simple ternary copper steels, although some preliminary results on quaternary steels containing copper have been obtained.

Unlike carbon steels, which harden on quenching, copper-iron alloys subject to precipitation-hardening are softest in the quenched condition, and harden on heating at an intermediate temperature that would soften a quenched carbon steel. According to the current theory of precipitation-hardening, the effect is due to the copper, retained in meta-stable solid solution by rapid cooling, being thrown out of true solution into a critically-dispersed form (which may or may not be a true precipitate) on reheating to a temperature that confers sufficient atomic mobility to allow the change to take place. Heating at too high a temperature or for too long a time results in softening, due to the growth of the copper particles to a size too large to have much hardening effect. Both time and temperature of treatment must therefore be considered of equal importance.

To determine the influence of speed of cooling from the solution heat-treatment, samples of several alloys were cooled from both 800 and 900 deg. C. at nine different rates. Hardness measurements were taken and the specimens then reheated at various temperatures to determine the extent of precipitation-hardening following the various cooling rates.

Summary and Conclusions.

In the course of their conclusions the authors remark that steels containing more than 0.7 per cent. copper are capable of being hardened by precipitation, and possess the best properties after normalising (air-cooling) from temperatures in the neighbourhood of 800 deg. C. and reheating to cause precipitation of the copper retained in meta-stable solution by the normalising treatment. Unlike most precipitation-hardening alloys, quenching or other rapid cooling following the solution heat-treatment is not necessary. A free-air cooling even of comparatively heavy sections is sufficient to give almost maximum properties after reheating. Some precipitation-hardening occurs during the cooling operation if the rate is less than 25 deg. C. per min., but the final properties after reheating are not affected until the rate is less than 1.5 deg. C. per min. The precipitation treatment may be applied directly to hot-rolled or forged shapes without special normalising treatment. The simplicity of the precipitation treatment and the fact that quenching, with its attendant danger of warping or cracking, is not necessary, should render the steels very useful in many applications where a cheap medium-strength steel is required without expensive heat-treatment, or where complicated sections are concerned.

Curves show the interdependence of time and temperature for the reheating treatment. Maximum hardness is obtained in 24 hrs. at 450 deg. C., 4 hrs. at 500 C. and 15 min. at 600 deg. C.; with longer times the steel softens again. Equally good results can be obtained if the steels are air-cooled from the high-temperature solution heat-treatment to about 500 deg. C. and maintained there for the precipitation treatment without intermediate cooling to room temperatures. Precipitation-hardening first appears with about 0.7 per cent. copper and reaches a maximum with 1.5 per cent. copper, beyond which no advantage is gained except in the quenched condition. Precipitation-hardening is additive to the base hardness of carbon steels, although the increase due to precipitation becomes rather less as the carbon content is increased.

As an example of typical properties, a steel containing 1.45 per cent. copper, 0.202 per cent. carbon, had a yield point in the normalised condition of 69,600 lbs. per sq. in., tensile strength 85,200 lbs. per sq. in., elongation 29.5 per cent., reduction of area 60.1 per cent. and Brinell hardness 170. Reheating for 4 hrs. at 500 deg. C. increased the yield point and tensile strength to 90,000 and 107,800 lbs. per sq. in. respectively, while the elongation and reduction of area dropped to 23.5 and 54.8 per cent., the Brinell hardness being 223. These results were obtained on laboratory melts and commercial heats would undoubtedly be superior.

Analysis of Coal Ash.

In connection with the physical and chemical survey of the national coal resources, the Department of Scientific and Industrial Research has issued a Fuel Research Survey Paper dealing with the methods of analysis of coal ash. This Report does not purport to be a treatise on the subject, but is put forward—in the absence of any recognised scheme for the analysis of coal ash—in the hope that it will form a basis upon which to build a complete collection of methods for all types of coal ash and all constituents that may occur in them.

Coal ash consists of a complex mixture of elements, mainly present as oxides (or, in combination with silica, as silicates), and generally some sulphates. The Report deals with the determination of the commoner of these, which constitute the major part of most ashes. The methods described have been selected, after extended trials and with such adaptations as experience has shown to be desirable, from those already recognised for the analysis of silicate rocks and other materials similar in composition to coal ash. Methods are given for the separation and estimation of silica, iron, titanium, aluminium, calcium, manganese, magnesium, phosphorus, alkalis and sulphur trioxide. Of these, the precipitation of titanium by "cupferron" solution is an interesting example of the newer practice—which seems likely to be increasingly adopted in the future—of employing organic reagents in place of inorganic reagents.

In addition to these major constituents, there occur smaller and variable amounts of constituents which may have an important bearing upon the properties and uses of the coal. Methods for the determination of some of these are still under investigation and are therefore not included in the Report.

Many other elements, some of them classed with the rare elements, have been detected from time to time in coal or coal ash, and an appendix gives a bibliography of reported occurrences of these. Formerly their presence was mainly a matter of purely scientific or academic interest, but in view of their possible action as catalysts in certain processes of coal utilisation (*e.g.*, hydrogenation), their detection and determination has recently assumed considerable practical importance. Since they occur generally in small amounts—often as mere traces—this is likely to be a matter of considerable difficulty, but the Report states that the progress already made in spectrum analysis indicates that this may prove a satisfactory and rapid method of determining not only the presence but also the amounts of certain of these elements.

Time Studies in Foundry Work.

By V. Bernard (Technical Manager of the Rosières Foundries).

[French Exchange Paper.]

(*Concluded from page* 98.)

Determination of θ and $t + t'$.

These determinations were effected by means of wagon A, which was well lubricated and was otherwise in good condition. The distances covered were over a section of track which may be regarded as representing the average condition of the system. The successive distances covered (10, 20, 30 to 90 metres) were in some cases interrupted by turntables: there was none on the 10-, 20- and 30-metre runs; one on each of the 40- and 50-metre runs, and two on each of the 60- to 90-metre runs. As previous experiments had shown that the slowing-down for crossing a turntable with total loads varying from 310 to 1,610 kg. (useful load 0 to 1,300 kg.) represented a time loss of 0.01 to 0.0225 mins., this insignificant cause of error was disregarded.

Rotation on Turntable.

The times necessary in effecting a rotation are shown for various loads in Table VII. The measurements were carried out with wagon A and two men on roller-bearing turntables in good condition (actuated by foot). The observed times relate to the interval between the moment when the wheels enter the first transverse groove and the moment when the rear wheels leave the second after turning. It should be noted that this operation is *preceded* by a slowing down of the wagon identical with that which occurs when one haulage is finished and *is followed* by another start ($t + t'$).

Conclusion.—The rotation time on a ball-bearing turntable works out at 0.13 to 0.15 mins. per ton of total load between 800 and 1,600 kg. Above this, the pressure on the bearings is heavy and the unitary time shows a sharp increase. Referred to tonnage of useful load the rotation time works out at 0.19 secs. for loads varying between 500 and 1,300 kg. The empty rotation time is 0.09 mins.

Table IV.—*Measurement of T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8, and T_9 in Hundredth Parts of a Minute.*

Loads hauled.			T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9
Dead load.	Useful load.	Total load.	10 m.	20 m.	30 m.	40 m.	50 m.	60 m.	70 m.	80 m.	90 m.
kg.	kg.	kg.									
310	0	310	16–16–17	25–26	39–39	55–54	70–68				
			M = 16.33	M = 25.5	M = 39	M = 54.5	M = 69				
310	700	1,010	20–21	37–37	53–54	71–71	87–88	101–96	109–118	128–128	140–145
			22–20						125–113		
			M = 20.75	M = 37	M = 53.5	M = 71	M = 87.5	M = 98.5	M = 116.25	M = 128	M = 142.5
310	1,300	1,610	27–27	48–50	65–67	87–84	105–108	125–118	114–138	161–151	179–176
			M = 27	M = 49	M = 66	M = 85.5	M = 106.5	M = 121.5	M = 141	M = 156	M = 177.5

Table V.—*Calculation of θ and $t + t'$ in Hundredth Parts of a Minute.*

Useful load hauled : 0 kg.		Useful load hauled : 700 kg.		Useful load hauled : 1,300 kg.	
Calculation of θ 10 m.	Calculation of $t + t'$	Calculation of θ 10 m.	Calculation of $t + t'$	Calculation of θ 10 m.	Calculation of $t + t'$.
$T_2 - T_1 = 9.17$	$16.33 - (13.16 \times 1) = 3.17$	$T_2 - T_1 = 16.25$	$20.75 - (15.21 \times 1) = 5.54$	$T_2 - T_1 = 22.0$	$27 - (18.81 \times 1) = 8.19$
$T_3 - T_2 = 13.5$	$25.5 - (13.16 \times 2) = -0.82$	$T_3 - T_2 = 16.5$	$37 - (15.21 \times 2) = 6.58$	$T_3 - T_2 = 17.0$	$49 - (18.81 \times 2) = 11.38$
$T_4 - T_3 = 15.5$	$39 - (13.16 \times 3) = -0.48$	$T_4 - T_3 = 17.5$	$53.5 - (15.21 \times 3) = 7.87$	$T_4 - T_3 = 19.5$	$66 - (18.81 \times 3) = 9.57$
$T_5 - T_4 = 14.5$	$54.5 - (13.16 \times 4) = 1.86$	$T_5 - T_4 = 16.5$	$71 - (15.21 \times 4) = 10.16$	$T_5 - T_4 = 21.0$	$85.5 - (18.81 \times 4) = 10.26$
Total 52.67	Total 5.03	$T_6 - T_5 = 11.0$	$87.5 - (15.21 \times 5) = 11.45$	$T_6 - T_5 = 15.0$	$106.5 - (18.81 \times 5) = 12.45$
θ average :		$T_7 - T_6 = 17.75$	$98.5 - (15.21 \times 6) = 7.24$	$T_7 - T_6 = 19.5$	$121.5 - (18.81 \times 6) = 8.64$
$\frac{52.67}{4} = 13.16$	average : $\frac{5.03}{2} = 2.51$	$T_8 - T_7 = 11.75$	$116.25 - (15.21 \times 7) = 9.78$	$T_8 - T_7 = 15.0$	$141.0 - (18.81 \times 7) = 9.33$
		$T_9 - T_8 = 14.5$	$128.0 - (15.21 \times 8) = 6.32$	$T_9 - T_8 = 21.5$	$156 - (18.81 \times 8) = 5.52$
	(doubtful)	Total 121.75	Total 64.94	Total 150.5	Total 75.34
		θ average :	average :	θ average :	average :
		$\frac{121.75}{8} = 15.21$	$\frac{64.94}{8} = 8.1175$	$\frac{150.5}{8} = 18.81$	$\frac{75.34}{8} = 9.4175$
		θ = 15.21	$t + t'$ (700 kgs.) = 8.1175	θ = 18.81	$t + t'$ (1,300 kgs.) = 9.4175

The results of the measurements and the calculations are shown in Tables IV and V.

Conclusions.—Wagon A, when pushed by two men of average strength, the track being presumed to be in good condition, requires the following times per hectometre run, as a function of the load shown below, for a haulage of any distance:—Empty, 1.316 mins.; loaded to 700 kg., 1.521 mins.; loaded to 1,300 kg., 1.881 mins.

To the ascertained time the following figures should be added for starting and stopping:—Empty, 0.025 mins.; loaded to 700 kg., 0.081 mins.; loaded to 1,300 kg., 0.094 mins.

With these particulars it is permissible to determine by interpolation the haulage time per hectometre for intermediate loads, as set out in Table VI.

Summary.

The tests described above provide the coefficients necessary for calculating the time to be allowed for any transport operation whatsoever, subject to the determination in each particular case of: the loading time; the unloading time; the distance to be covered, and the number of turntables on which the wagons have to be turned.

Table VI.

Useful load.	Time in mins.	$t + t'$.
0 kg.	1.31	0.025
500 ,,	1.46	0.077
600 ,,	1.49	0.099
700 ,,	1.52	0.081
800 ,,	1.58	0.083
900 ,,	1.64	0.085
1,000 ,,	1.70	0.088
1,100 ,,	1.76	0.090
1,200 ,,	1.82	0.092
1,300 ,,	1.88	0.094

This result is obtained by applying the following formula: $T = C + D + P(\theta_c + \theta_v) + p(R_c + R_v) + (t + t'_c) + (t + t'_v) + p(t + t'_c + t + t'_v)$, in which:

T = the time required per ton for the *outward journey loaded* and the *return journey empty*, or *vice versa*, by the *same route*.

C = the loading time for one ton.

D = the unloading time for one ton.

P = the length of the *single* journey in hectometres.

p = the number of rotations on turntables for the single journey.

θ_c = the haulage time per *ton-hectometre* for the load and wagon in question, with two men.

θ_v = the haulage time for the *empty wagon* over one hectometre, with two men.

R_c = the rotation time per *useful ton* on a roller-bearing turntable for the load and wagon in question

R_v = the rotation time for the *empty wagon* on a roller-bearing turntable.

$t + t'_c$ = the time lost in starting and stopping *when loaded*, for the load and wagon in question.

$t + t'_v$ = the time lost in starting and stopping with the wagon *empty*.

By calculating the totals $\theta_c + \theta_v$; $R_c + R_v$, $t + t'_c + t + t'_v$ in advance and calling these totals θ, R and t respectively we simplify the calculations and the formula, which becomes:

$$T = C + D + P\theta + pR + [p + 1\ (+)].$$

Table VIII gives the values of θ, R and t for wagons A and B and the various useful loads. These values are derived from those given in Tables VI and VII. For the sake of simplification, the effect of the variations of load on R and t has been disregarded, this being indicated by a sufficiently approximate average value.

Until the tare of the platform-type wagons, which are indispensable for the transport of material unsuitable for the tipping-type wagons, can be uniformly reduced approximately to that of the above wagons (< 360 kg.) it is necessary to take the figures, detailed in Table IX, as the value of θ as a function of the load, when these wagons are used.

Conclusions.

(1) A chronometric system has been employed at the Rosières Foundries for the past twelve

years, and has been applied successively to all repetition work. It has been finally accepted by the staff, who make no apparent difficulty when the official of the time-study office comes to make his observations. On the other hand, the services

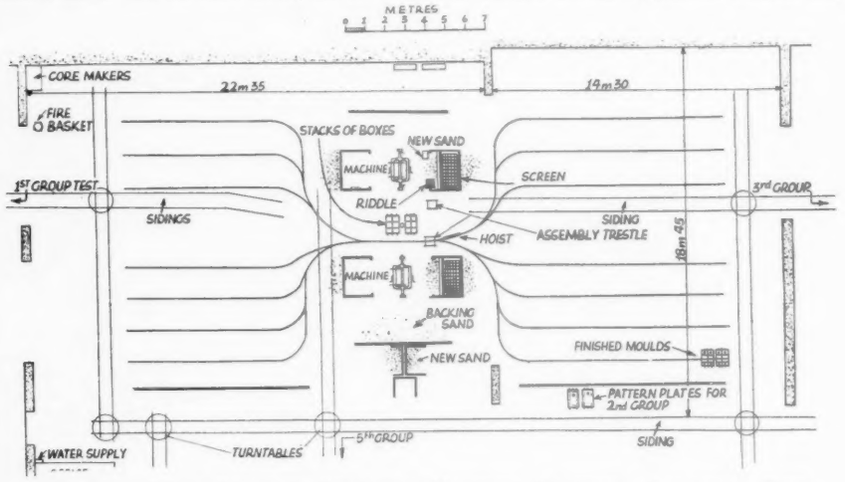

Fig. 12.—Third Group of Hydraulic Moulding Machines. Lay-out of Shop.

of the time recorder have sometimes been requested by workmen who considered that their work was inadequately paid. For a total staff of about 1,000 men, of whom about 875 are workmen, the time-recording operations constantly occupy four officials.

(2) In most cases the piece-work prices, based on the timing, have been adopted without difficulty. Moreover, when a piece-work rate is disputed, there is a general conviction that the difference can be due to only two reasons, viz.:—That the time recorder has committed an error or that the working method in use when the measurements were carried out has subsequently been subjected to modification. In all cases the question is one of fact, which can easily be determined.

(3) When the rectification takes the form of a reduction in the times allowed and the prices based on them, it is accepted by the staff, naturally, without enthusiasm, but at the same time without serious opposition, because they are aware that they will be furnished with proof of the error committed whenever they desire, and frequently, also, because they have themselves detected the error before the timing office intervened.

(4) Time and patience are required in establishing a good timing office, but the suppression of wage disputes, with its beneficial results, amply compensates the management for its trouble and expenditure. In their analyses of the work, moreover, the time recorders frequently reveal anomalies of detail which without their work would not be remedied.

(5) Hitherto the writer has experienced no serious difficulties except in connection with determining the normal times for fettling and polishing work. This is due to the fact that the time necessary for removing the burrs with the wheel or in obtaining a polished surface is essentially dependent on the force exercised by the workman in applying the casting to the tool. This force cannot be estimated by the time recorder, and, consequently, he may very easily fall into error. It was found impossible to establish times which were approximately correct until the staff had succeeded in gaining the confidence of a conscientious workman in each of the shops concerned.

Table VII.—*Times Utilised at Turntables.*

Weight empty.	Load.		Observed time, average.	Duration of rotation for 1 ton.	
	Useful.	Total.		Useful load.	Total load.
310 kg.	0 kg.	310 kg.	0.09	—	0.27
310 ,,	500 ,,	810 ,,	0.11	0.22	0.13
310 ,,	700 ,,	1,010 ,,	0.13	0.18	0.13
310 ,,	900 ,,	1,210 ,,	0.18	0.20	0.15
310 ,,	1,100 ,,	1,410 ,,	0.21	0.19	0.15
310 ,,	1,300 ,,	1,610 ,,	0.24	0.18	0.15
310 ,,	1,500 ,,	1,810 ,,	0.42	0.28	0.23

Table VIII.

Wagons A and B (Decauville 500 and 750-litre tipping wagons, tares 310 and 360 kg.).

Useful load.	θ	R	t
700 kg.	3.48	Constant = 0.28	Constant = 0.11
800 ,,	3.28		
900 ,,	3.14		
1,000 ,,	3.01		
1,100 ,,	2.91		
1,200 ,,	2.82		
1,300 ,,	2.76		

Table IX.

Useful load.	θ		
	Wagon C.	Wagons D and E.	
700 kg.	4.23	3.79	
800 ,,	3.79	3.48	
900 ,,	3.48	3.28	R = constant = 0.28.
1,000 ,,	3.28	3.14	t = constant = 0.11.
1,100 ,,	3.14	3.01	
1,200 ,,	3.01	2.91	
1,300 ,,	2.91	2.82	

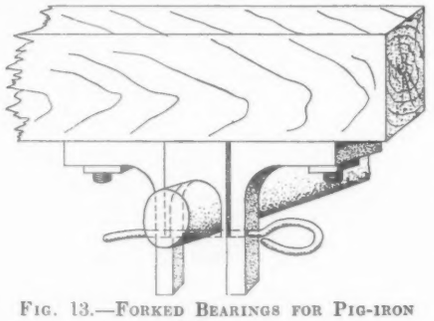

Fig. 13.—Forked Bearings for Pig-iron Trucks.

Licensing of Machinery Imports.

REVISION OF CLASSES.

The Import Duties Advisory Committee have recommended, and the Treasury have approved, the revision in certain respects of the classes or descriptions of machinery to which Section 10 of the Finance Act, 1932, applies. The provisions of Section 10 of the Finance Act are as follow:—

10.—(1) If, in any case where it is proposed to import into the United Kingdom any consignment of machinery of a class or description to which this section applies, the Import Duties Advisory Committee are satisfied that machinery similar to that consignment is not for the time being procurable in the United Kingdom, and are of opinion that, having regard to all the circumstances, it is expedient that the consignment should be allowed to be imported without payment of all or any of the duties chargeable under the Import Duties Act, 1932, the Committee may make a recommendation to the Treasury accordingly, and the Treasury, after consultation with the Board of Trade, may by licence authorise the importation of the consignment in accordance with the recommendation.

(2) The Committee may at any time recommend that this section shall apply to any class or description of machinery, or shall cease to apply to any class or description of machinery to which it previously applied, and where any such recommendation is approved by the Treasury, this section shall apply or cease to apply accordingly.

It will be appreciated that the effect of listing a class of machinery under the Section is not to free machinery of that class generally from import duty. Licences are only issued in respect of particular consignments, where it is found that the requirements of the Section concerning non-procurability in this country, etc., are satisfied. It should be added that the Committee are unable to entertain applications received by them after the consignment has been imported, or where duty has been paid outright.

The revised list includes the following:—Machine tools, metal working and finishing and wood-working machinery; battery-making machinery; foundry machinery; wire-working and wire-winding machinery; testing machinery; and presses.

Application may be made by or on behalf of a firm purchasing machinery for their own use, or by an importer having the sole agency for the sale of a particular machine in this country. The appropriate forms of application may be obtained on request in writing from the Secretary, Import Duties Advisory Committee, Caxton House (West Block), Tothill Street, Westminster, S.W.1.

Czecho-Slovak Notes.

Although there is no definite sign of a revival in the iron and steel trades, the situation is considered encouraging as compared with that of a year ago, and there seems to be no immediate danger of production again falling back to the record low figures of 1932. The outputs of pig-iron and steel during the first quarter of 1933 were about 27 and 33 per cent. of capacity respectively. Between May and June there was a slight setback as compared with the preceding months. Pig-iron fell from 48,000 to 46,000 metric tons, whereas during the same period last year it had increased from 33,000 to 35,000 metric tons. Similarly, steel output fell back from 86,000 to 70,000 metric tons, as against an increase in the preceding year from 55,000 to 66,000 metric tons.

The directors of the Skoda Works, Limited, in the annual report for 1932, make reference to international trade barriers, including currency measures adopted by various States, which rendered imperative further reductions in working costs. Operating profit and interest amounted to Kc. 63,907,150, compared with Kc. 132,436,472 in 1931. After providing for taxes and social welfare contributions, Kc. 33,572,841 remains, which is allocated for depreciation. The carry forward is unchanged at Kc. 11,074.294. The last dividend was 28½ per cent., in 1930. Following the further, though more moderate, fall in sterling, the difference on exchange on the sterling debentures increased from Kc. 103,000,000 to Kc. 106,000,000. In the balance-sheet, fixed assets show a net reduction of Kc. 18,674,175, being Kc. 33,572,841 written off for depreciation, less capital expenditure, during the year, chiefly expended in opening up the new colliery in Nyrany, which is now in production. Stocks of raw materials, work in hand, and finished products have again decreased, by Kc. 10,450,579.

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C.N.113

This Week's News in Brief.

Trade Talk.

Messrs. Alexander Stephen & Sons, Limited, Linthouse, Glasgow, have booked an order to build a cargo steamer for the Union Steamship Company, of New Zealand. The vessel will be approximately 270 ft. in length.

The Clyde Navigation Trustees are inviting tenders for the construction of three cross-river ferryboats. There are alternative specifications for the vessels providing for steam and internal-combustion engines. Tenders are to be lodged by September 11.

Messrs. Workman Clark (1928), Limited, Belfast, have obtained an order to build two 10,000-ton motorships for the New Zealand Shipping Company, Limited. The vessels, which are for cargo transport, represent the second order received by the firm in three weeks.

An addition has been made to the motor-boat fleet at Rothesay by the launch of the "Brendon," a powerfully-engined craft built by Mr. James Taylor for his own trade. She will be used for passenger and newspaper service between Bute and the mainland, and is fitted with an exterior keel and rolling chocks.

Messrs. Harland & Wolff, Limited, have launched from their Govan yard the twin-screw passenger and cargo steamer "Prabhavati," built to the order of the Bombay Steam Navigation Company, Limited, Bombay. The propelling machinery supplied by the firm's Belfast works consists of two sets of triple-expansion engines and one double-ended boiler designed for either coal or oil firing.

Marshall, Sons & Company, Limited, Britannia Iron Works, Gainsborough, have recently received orders for "Marshall" Diesel road rollers from the War Office; County Borough of Wolverhampton; County Borough of Brighton; Borough of Worthing; Borough of Reigate; Dorking Urban District Council; Wolverton Urban District Council and Sutton-in-Ashfield Urban District Council.

For the third successive time an application for a foundry extension came before the Falkirk Dean of Guild Court last week. The petitioners on this occasion were Messrs. M. Cockburn & Company, Limited, Gowanbank Iron Works, who asked for permission to take down a pipe-dipping department and erect an extension to the fitting shop. The court appeared to be very pleased to grant the application.

Messrs. William Simons & Company, Limited, Renfrew, have secured two contracts to build dredgers for overseas. One is for a large Diesel-engined dredger for service in Burmah. She will be the largest of her type ever built in this country, and one of the most powerful. The propelling machinery will be capable of developing 3,200 h.p. The other order is for a steam-driven dredger for service in China, and like the other, will be of Messrs. Simons' patent cutter type.

The shipbreaking concerns in Bo'ness are assured of a busy time this winter. The Holland-American liner "Westerdijk," of 8,267 tons, arrived in Bo'ness roads last week. Following a recent decision by the company, she was offered for sale along with another two vessels of similar dimensions belonging to the Dutch company. Messrs. P. & W. MacLellan, Limited, of Glasgow and Bo'ness, were the successful bidders for the "Westerdijk" and her sister ship "Eemdijk," while the third went to an Italian firm.

The Sure Arc Electrode Company, Limited (connected with the North Eastern Welding Company, Limited, Stell Road, Aberdeen), has secured a further order from the Southern Railway for four petrol and two electric welding sets for permanent-way work. Orders have also been received from the London Electric Railway for one electric-welding set and from the Great Southern Railways, Ireland, for a petrol-driven set for permanent-way work. The firm have since November been engaged in the manufacture of 37 welding sets.

With the reconstruction of four bridges for which plans are now being prepared, the L.M.S. Railway will have completed an intensive programme of strengthening bridges in various parts of their system in order to enable more extensive use to be made of the heavier and more powerful locomotives now in service. Under this scheme, which was begun in 1929, some 44 bridges have already been rebuilt, and the four now in hand represent the last item in the programme. The routes to which this scheme has been applied are between Pye Bridge (on the Trent and Chesterfield Line) and Leeds; and between Clay Cross, south of Chesterfield, and Wichnor (between Derby and Birmingham).

The Tunnel Portland Cement Company, Limited, have just negotiated an agreement with the Clyde Navigation Trustees for the lease of ground at Rothesay Dock, Clydebank. A new cement factory which is now in course of erection will be operated by a new company subsidiary to the Tunnel Portland Cement Company, which, whilst controlled by the Tunnel Company financially, will be supported by Scottish capital and will be known as the Clyde Portland Cement Company, Limited, and the board of directors will include at least two Scottish members, of whom Sir William Alexander, M.P. for Glasgow Central, is expected to be one. Other directors will be selected from the board of the Tunnel Company, which includes Mr. Edwin H. Lewis, a former manager of the Glasgow Iron & Steel Company, Limited, and former President of the West of Scotland Iron and Steel Institute.

Obituary.

We sincerely regret to record the death of Sir K. Vaughan-Morgan, M.P., who died last Monday, in his sixtieth year, in a London nursing home. Apart from his political activities—he was Member of Parliament for Fulham—Sir Kenyon Vaughan-Morgan did much social work, being a Governor of several of the large London hospitals, and also had a distinguished military career. He was vice-chairman of the Morgan Crucible Company, Limited, of Battersea.

The death occurred on August 11 of Mr. Henry B. Morice. He had been at business during the day, but had a seizure in the evening and died in a few hours. Mr. Morice, who was 59 years of age, was a native of Aberdeen. He served an apprenticeship with Messrs. John Lewis & Sons, Limited, shipbuilders and engineers, and later was foreman engineer for a number of years. He then became consulting engineer to the Aberdeen Mutual Assurance Society, and later superintendent engineer with Messrs. Pirie & Smith, consulting engineers, Aberdeen. At the time of his death he was superintendent engineer for Mr. T. Davidson, trawler owner.

Company Meeting.

Bengal Iron Company, Limited.

At the fifteenth ordinary general meeting of the Bengal Iron Company, Limited, held in London last week, Mr. Wm. Turner MacLellan, C.B.E. (chairman and managing director), said that business during the past year continued on a very low level. They were, in their foundries, however, this year busier than they had been for some time, and the railways had already ordered more from them this year than they did during the whole of last year. He regretted that he saw no immediate signs of restarting their blast furnaces until the pig-iron trade of the world improved materially, but the outlook of this trade in India was much better than it had been for some years.

Contracts Open.

Rugby, September 9.—Water pipes and specials, for Rugby Rural District Council. The Surveyor, Temple Street, Rugby.

Manchester, August 23.—12,000 yds. of 8-in. s. and s. water pipes, for the Corporation Waterworks Committee. The Chief Engineer, Waterworks Offices, Town Hall, Manchester 2.

New Company.

A. Arc, Limited, 123, Cannon Street, E.C.4.—Capital, £5,000 in £1 shares. Manufacturers of electrodes for electric and other forms of welding and soldering, etc. Directors: L. M. Neumann and E. W. H. Fairbairn.

Personal.

Mr. Auguste Le Thomas, the director of the French Foundry Research Association, has had the decoration of Officer of the Legion of Honour bestowed upon him by the Minister controlling the French Admiralty.

Mr. Henri Coquegnot, Vice-President of Chavanne-Brun Frères, managing director of the Société Métallurgique d'Aubrives-Villerupt and of the Société Minière des Terres Rouges, and a director of the French "Griffin" Company, has been appointed general manager of the Hagondange concern and of the Union des Consommateurs de Produits Métallurgiques.

Congratulations are due to Mr. C. J. Dadswell on gaining the second place in the passing-out examinations at the Paris Foundry High School. Considering the language difficulty, it is extremely creditable for an Englishman to assume the second position in the general classification. He was beaten by Mr. Josset, who is a French foundry manager of 35 years of age. Mr. Dadswell is the first Britisher ever to pass the examinations. It will be remembered that he won a Robert Blair travelling fellowship, and when the period terminates next month he will rejoin the staff of the English Steel Corporation. Before taking up the fellowship, Mr. Dadswell was assistant foundry manager at their Grimesthorpe Works, Sheffield.

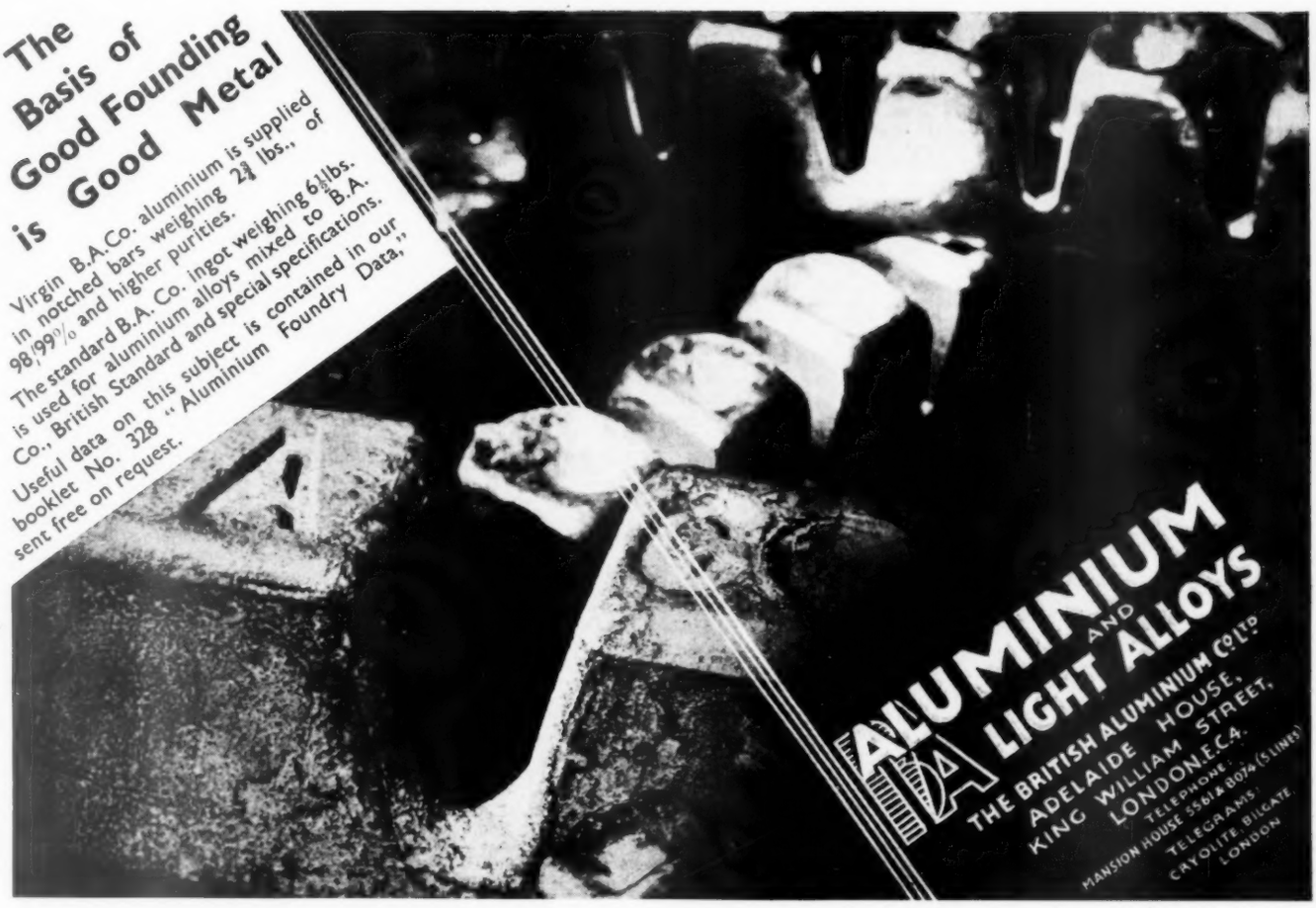
Mr. G. W. Barr, of Barrow-in-Furness, has been appointed deputy managing director under Sir Alexander M. Kennedy, chairman and managing director, of the Fairfield Shipbuilding & Engineering Company, Limited, Govan, Glasgow, in place of Mr. A. J. Hendin, who, after 30 years' service with the company, has resigned from the positions of director and shipyard manager. Mr. Barr, who is a son of Mr. John Barr, Past-President of the Shipbuilding Employers' Federation and now general manager of National Shipbuilders' Security, Limited, has had considerable experience in the construction of passenger vessels and all classes of warships, types of work in which the Fairfield Company has specialised. During the war he was shipyard manager for Messrs. William Beardmore & Company, Limited, Dalmuir, and he has also had wide experience at Barrow and on the Tyne.

Will.

Crisp, F., of Hall Green, Birmingham, brassfounder £9,321

Falkirk Light-Castings Trade.

Trade generally in Falkirk district and especially in the light-castings industry appears to have improved appreciably, and it is reported that the number of unemployed has decreased steadily in recent months. The Employment Exchange registers show a reduction of nearly 2,000 on the unemployed roll. Owing to intensive housing programmes which are being carried through all over the country, the demand for the products of the foundries has increased, and some of the works have been able to give full-time employment to their staffs and in several cases to supplement the number of workers. Proof of the revival is to be found in the fact that a number of moulders who left to work in England have returned to the town and have been successful in finding employment. The number of men returning does not in any way compare with the great exodus during the depression, but nevertheless this is an indication that the light-castings trade is brightening up. An official of the Ironfitters' Association states that the present improvement has been the greatest for the past four years. The men employed in the castings industry have increased by about 33 per cent., and this figure is likely to be exceeded. The quota system of engaging men has proved generally beneficial. Although the boom was more or less expected, several prominent foundry officials have expressed themselves as agreeably surprised at its magnitude, and that it had extended beyond the period forecast by the experts.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Useful data on this subject is contained in our booklet No. 328 "Aluminium Foundry Data," sent free on request.
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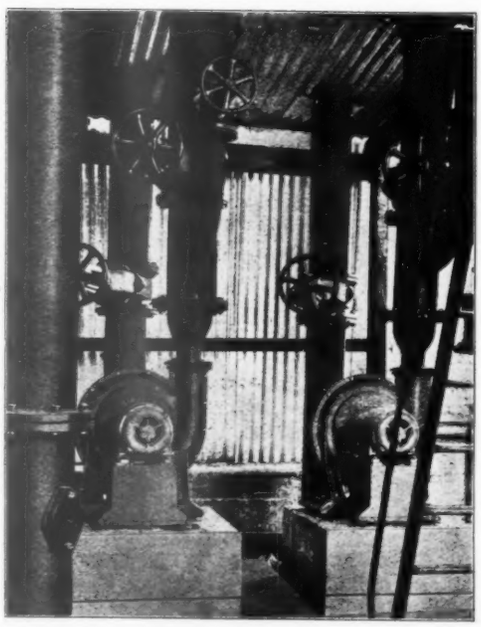
A NEW TRADE SIROCCO MARK CATALOGUE!



No. S.F. 26 dealing with "Sirocco" Fan Manufactures for moderate and high pressures. It includes some interesting examples of recent installations and contains detailed and accurate information concerning duties, weights and dimensions for the wide range of sizes and designs listed. In addition, numerous tables assist in determining the most suitable "Sirocco" Fan Equipment for use under diverse operating conditions.

A copy for reference is indispensable.

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Raw Material Markets.

In spite of the fact that activity in the iron and steel markets has been considerably restricted by holiday influences, a strong feeling of optimism generally prevails, and an autumn revival in business is confidently looked for. At the moment, business in pig-iron remains limited, but inquiries show that consumers are taking more interest in forward deliveries, although a considerable amount of contracting has already been done.

Pig-Iron.

MIDDLESBROUGH.—Business is very slow at the moment, on seasonal grounds. Owing to the reduced rate of consumption, additions are having to be made to the maker's stocks, but there is little doubt that these will only be of a temporary nature. A number of local users have entered into contracts over periods ahead, owing, it is said, to fears of a rise in prices. It is true that coke prices have been moving up, but the increase so far is not sufficient to warrant any move in quotations, which therefore remain at 62s. 6d. for No. 3 Cleveland G.M.B. in the Middlesbrough area, 64s. 6d. per ton delivered elsewhere on the North-East Coast, 62s. 3d. delivered Falkirk and 65s. 3d. delivered Glasgow. No. 1 foundry iron remains at a premium of 2s. 6d. per ton, and both No. 4 foundry and No. 4 forge iron are quoted 1s. per ton less than No. 3 G.M.B.

In the East Coast hematite market, there has been no change with regard to the price situation, but there are still strong possibilities of a rise. Considerable tonnages of local iron continue to be sent to steelmakers in the Midlands and South Wales, and prospects for the autumn are distinctly encouraging. Some makers who are carrying stocks refuse to dispose of them at the present prices, but others are willing to do so, and hence quotations remain at 59s. for mixed numbers. Slightly less would be accepted for export.

LANCASHIRE.—The forward buying movement experienced recently in the Lancashire pig-iron market has now spent itself, and, many consumers now being covered for some months ahead, a period of dull trading may be looked forward to. Prices are fairly firm generally. For delivery to users in the Manchester zone, Staffordshire and Derbyshire brands of No. 3 iron are on offer on the basis of 67s. per ton, with North-East Coast foundry iron at round the same figure, Northamptonshire at 65s. 6d., and Derbyshire forge at 62s. East Coast hematite has latterly been displaying a somewhat firmer tendency, and values for delivery equal to Manchester are now in the region of 74s. to 74s. 6d. per ton, with West Coast at 80s. 6d. Sales of Scottish pig-iron in the Lancashire area are on a small scale, the competition from Indian brands still being a formidable factor; the delivered prices for Scottish in this district are in the region of 80s. per ton. Values of machinery scrap continue to show a slightly firmer tendency, light scrap of good quality being on offer at the range of 32s. 6d. to 40s. per ton, according to local conditions, and including delivery to users' works.

MIDLANDS.—Work has now been resumed in this area after the stoppage. Light-castings manufacturers are very actively engaged at the moment, and one or two of the heavy engineers are not so badly placed as they were. Most of the big consumers of foundry pig-iron are now covered, many of them until the end of the year, at the present rates of 62s. 6d. for Northants No. 3 and 66s. for Derbyshire, Lincolnshire and North Staffs No. 3, including delivery to South Staffs. Any forge pig-iron wanted at foundries is 4s. per ton below the No. 3 level. There is still no sign of Continental foundry pig-iron being competitive in South Staffs, and very shortly Cleveland may cease to be competitive in this area. For some months past it has been on offer at the same price as Derbyshire, namely, 66s., but as the Cleveland ironmasters have sold heavily they may not be willing to take such a low price as 66s. There continues to be a fair demand for special foundry iron. Scottish No. 3 is offered at about 85s.; this is a medium-phosphorus pig, and other medium-phosphorus irons are offered from other sources between 70s. and 75s., with low-phosphorus grades of iron from 80s. to 90s. There is also a demand for refined pig-iron, prices for which vary considerably from £5 to £6 15s.

SCOTLAND.—Generally speaking, current business is confined to small purchases for immediate needs. The one bright feature of the market at the present moment is the slightly better demand for foundry iron in the light-castings trade, particularly in the Falkirk area. There is no change to report in prices, and the official minimum of 65s. f.o.t. furnaces for No. 3 foundry is still operating, with a minimum of 2s. 6d. per ton extra for No. 1. The Falkirk founders are using more iron and are being asked to pay 62s. 3d. f.o.t. Falkirk for No. 3 Middlesbrough, with other English irons obtainable at 2s. 3d. per ton less. For the Glasgow area the price of No. 3 Middlesbrough is 65s. 3d., with Midland foundry at 63s.

Coke.

The demand for foundry coke remains slow, and consumers are so far evincing little desire to enter into forward contracts, although they usually do so at this period of the year. Quotations in the South Staffordshire area remain as follow:—Best Durham brands, 30s. to 38s. per ton; Scottish coke, 39s. to 40s.; Welsh coke, 28s. to 45s., according to analysis.

Steel.

There has been some decline in the volume of business, due to the seasonal influences, states the official report of the London Iron and Steel Exchange. The position, however, is sound, since most of the British works have a good tonnage of orders in hand and can afford to face with equanimity the decline in business which usually takes place during the holiday season. Quiet conditions rule in the semi-finished department. Continental sellers, who a short time ago were active in the British market, have withdrawn and the British producers again have this market practically to themselves. There is a tendency in some districts for prices to become slightly firmer and most of the makers are well supplied with orders for this class of material. In the finished-steel department the home-trade demand has declined somewhat; but of late there has been an improvement in inquiry from oversea customers, and it seems likely that a fair amount of this will develop into business.

Scrap.

Generally speaking, quotations for iron and steel scrap remain firm throughout the country. In the Cleveland area, fairly good supplies are available, and the foundries can cover their needs of ordinary cast iron at 39s. a ton, and of machinery metal at 41s. The scrap-iron market is firm in the Midlands, there being a steady demand from the foundries. Heavy-machinery scrap is at 47s. 6d., good pipe and plate at 45s., and clean light at 38s. 6d. to 40s. The chief feature of the South Wales market is the better call for light cast-iron scrap, which is firmer in price at about 40s. per ton. In Scotland the demand is very slow, even at current prices, which are 50s. for machinery scrap, 46s. for ordinary metal, and 38s. 9d. to 40s. for light cast iron, delivered f.o.t. consumers' works.

Metals.

Copper.—The weak tone in the copper market and the gradual fall in prices served to scare consumers away from the market, and few trade transactions have been reported this week. There has been a good deal of liquidation by holders lately, but the metal placed on the market was fairly well absorbed. Business with the Continent has not been very good. The copper situation in the United States has been further complicated by the Government attempt to force a national "code" upon the industry. If the U.S. Government manages to do what the producers themselves failed to achieve, and places the copper industry under national control, the result will certainly be a higher price level, at least in the domestic market.

The week's prices have been as follow:—

Cash.—Thursday, £35 7s. 6d. to £35 8s. 9d.; Friday, £36 2s. 6d. to £36 3s. 9d.; Monday, £35 12s. 6d. to £35 15s.; Tuesday, £35 12s. 6d. to £35 13s. 9d.; Wednesday, £35 11s. 3d. to £35 12s. 6d.

Three Months.—Thursday, £35 11s. 3d. to £35 12s. 6d.; Friday, £36 6s. 3d. to £36 7s. 6d.; Monday, £35 17s. 6d. to £36; Tuesday, £35 17s. 6d. to £35 18s. 9d.; Wednesday, £35 15s. to £35 17s. 6d.

Tin.—The tin market has presented no special feature this week. Consumption in this country shows no improvement, but the South Wales tinplate industry continues to take steady supplies of metal, in most cases direct from the smelters. Fears are expressed that there may be a shortage of supplies towards the end of the year, especially so in view of the number of recent shipments of English tin to New York. For the moment the position is stabilised by the fact that the Pool continues to make periodical releases from its large stocks on the London market. In the United States the tinplate manufacturers continue to experience "boom" conditions, and the general rate of consumption continues to improve. An early move by some tin producers to ease the present crushing restrictions on exports would not be surprising.

Daily quotations:—

Cash.—Thursday, £213 5s. to £213 10s.; Friday, £215 7s. 6d. to £215 10s.; Monday, £213 to £213 5s.; Tuesday, £213 2s. 6d. to £213 5s.; Wednesday, £213 2s. 6d. to £213 5s.

Three Months.—Thursday, £213 5s. to £213 10s.; Friday, £215 5s. to £215 10s.; Monday, £213 to £213 5s.; Tuesday, £213 5s. to £213 7s. 6d.; Wednesday, £213 to £213 5s.

Spelter.—The price of this metal fluctuates very little, and the market has quite a firm tone. Messrs. Rudolf Wolff and Company report that the trade demand continues quiet, consumers having refrained from purchasing other than their immediate requirements by reason of the easier tendency which the market has displayed, and the uncertainties which surround the general industrial situation. An active business, however, has been transacted on the London market, and the selling and liquidation which has taken place has only had a small influence on the course of prices. The market on the Continent is reported quiet with, however, a steady undertone. Trade demand there is light; holders at the same time display no anxiety to press sales, no doubt in the belief that values will recover when consumption develops further, and that the necessary support will be forthcoming by reason of the improving statistical position.

Price fluctuations:—

Ordinary.—Thursday, £16 12s. 6d.; Friday, £17; Monday, £16 15s.; Tuesday, £16 16s. 3d.; Wednesday, £16 16s. 3d.

Lead.—Business is not so active as it has been in recent weeks, as some works in this country are still closed for holidays, report Messrs. Henry Gardner. Prices have declined. On the decline the Continent showed more interest, buying moderately. Expectations are that more substantial buying will develop shortly, as the battery and sheet trades are both busy.

Daily market prices:—

Soft Foreign (Prompt).—Thursday, £11 15s.; Friday, £12 1s. 3d.; Monday, £11 18s. 9d.; Tuesday, £11 17s. 6d.; Wednesday, £11 17s. 6d.

Catalogue Received.

Industrial Measuring and Recording Instruments.—Messrs. Negretti & Zambra, of 38, Holborn Viaduct, London, in a 20-page brochure, describe and illustrate, using simple language and clearly-produced pictures, a wide range of pyrometers, draft gauges and pressure recorders. We think that page 20 requires a little more explanatory matter. It is obviously useful to those who have installed this firm's instruments for ordering replace parts. Moreover, information as to the nature of thermocouples incorporated in the Le Chatelier type of pyrometer would have been welcomed. However, this does not pretend to be a text book, and it has well achieved its purpose in emphasising the workmanship incorporated in their instruments and their policy of service after sales. We strongly recommend our readers to request the firm to furnish them with a copy for reference purposes.

Castings for High-Temperature Work.—In a recent issue of "The Iron Age," Mr. Thomas J. Wood gives the analyses of nickel-alloy castings that will withstand operating conditions of either high temperatures or oxidising atmospheres, or both, and describes investigations made at the research laboratory of the International Nickel Company.

JAS. GRAY & SONS, *Enamelling Engineers,*

Telegrams: "Grayasons, Sowest, London." **5, VICTORIA STREET, LONDON, S.W.1.** Telephone: VICTORIA 5794.

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ESCOL ENAMELS MEET EVERY REQUIREMENT.

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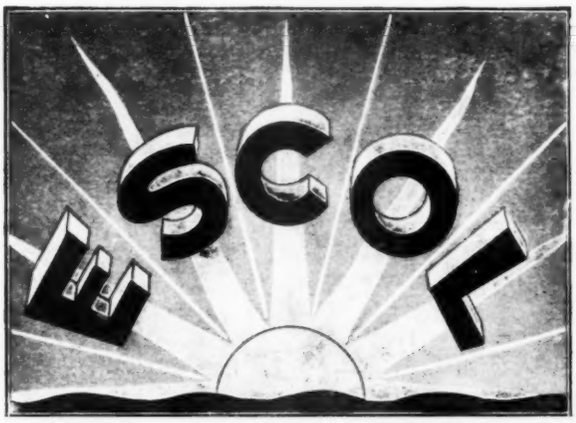

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PORCELAIN ENAMELS
FOR
CAST IRON AND SHEET METAL.

If you are considering the enamelling of your product—If you are at present engaged in enamelling—
WE CAN BE OF ASSISTANCE TO YOU.

Manufacturers: J. F. Stewart & Co., Ltd., Paisley Works, London, E.15.

CAST IRON FLANGED PIPES
2 in.—12 in. & CONNECTIONS. to 24 in. dia.
WE HAVE FIFTY-TWO YEARS OF ACCUMULATED EXPERIENCE AND METAL PATTERNS.
JAMES & RONALD RITCHIE, LTD.,
Telephone: 3852 (2 Lines). **MIDDLESBROUGH.** **Telegrams: "Ritchie, Middlesbrough."**

Colvilles PIG IRON
BRANDS "DALZELL", "GLENGARNOCK", "CLYDE" & "MONKLAND"
HIGH GRADE HEMATITE PIG IRON
SPECIAL & ORDINARY FOUNDRY QUALITIES & FORGE
SPECIAL REFINED WITH TOTAL CARBON
COLVILLES LTD
GLASGOW

XUM

RAW MATERIALS—PRICE LIST.

(Wednesday, August 23, 1933.)

COPPER.

	£ s. d.
Standard cash	35 11 3
Three months	35 15 0
Electrolytic	39 10 0
Tough	37 15 0
Best selected	38 5 0
Sheets	68 0 0
India	48 10 0
Wire bars	40 10 0
Ingot bars	40 10 0
H.C. wire rods	42 10 0
Off. av. cash, July	37 19 $0\frac{13}{16}$
Do., 3 mths., July	38 2 $3\frac{1}{2}$
Do., Sttlmnt., July	37 19 $4\frac{9}{16}$
Do., Electro, July	41 19 $6\frac{9}{16}$
Do., B.S., July	40 19 $4\frac{1}{2}$
Do., wire bars, July	42 8 $6\frac{9}{16}$
Solid drawn tubes	10½d.
Brazed tubes	10½d.
Wire	7d.

BRASS.

Solid drawn tubes	9½d.
Brazed tubes	11½d.
Rods, drawn	8½d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	7½d.
Wire	7½d.
Rolled metal	7⅜d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5¼d.

TIN.

	£ s. d.
Standard cash	213 2 6
Three months	213 0 0
English	213 15 0
Bars	214 15 0
Straits	219 12 6
Australian (nom.)	—
Eastern	219 0 0
Banca	219 2 6
Off. av. cash, July	216 15 $7\frac{9}{16}$
Do., 3 mths., July	216 12 $4\frac{1}{2}$
Do., Sttlmt., July	216 15 $2\frac{9}{16}$

SPELTER.

	£ s. d.
Ordinary	16 16 3
Remelted	16 15 0
Hard	14 5 0
Electro 99.9	19 0 0
English	17 10 0
India	16 10 0
Zinc dust	20 0 0
Zinc ashes	4 0 0
Off. aver., July	17 15 10
Aver. spot, July	17 15 $10\frac{9}{16}$

LEAD.

	£ s. d.
Soft foreign ppt.	11 17 6
Empire	12 2 6
English	13 5 0
Off. average, July	13 10 $2\frac{9}{16}$
Average spot, July	13 8 $2\frac{1}{2}$

ALUMINIUM.

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	25 15 0
Do., V.M. ex-whse.	25 5 0
Rods	30 10 0

ANTIMONY.

	£ s. d.
English	37 10 0 to 40 0 0
Chinese	26 15 0
Crude	—

QUICKSILVER.

	£ s. d.
Quicksilver	8 7 6 to 8 15 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	6 10 0
45/50%	12 10 0
75%	19 2 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free of Mo.	5/6 per lb.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£15 0 0
Ferro-tungsten—	
80/85%	1/9 lb.
Tungsten metal powder—	
98/99%	2/– lb.
Ferro-chrome—	
2/4% car.	25 10 0
4/6% car.	21 17 6
6/8% car.	19 7 6
8/10% car.	18 17 6
Ferro-chrome—	
Max. 2% car.	30 0 0
Max. 1% car.	31 0 0
Max. 0.70% car.	36 2 6
70% carbon-free	10d. lb.
Nickel—99.5/100%	£225 to £230
"F" nickel shot	£202 10 0
Ferro-cobalt	5/6 lb.
Metallic chromium—	
96/98%	2/8 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/2 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{1}{16}$ in.	1/– lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/– lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

South Wales—	£ s. d.	£ s. d.
Heavy steel		2 5 0
Bundled steel and shrngs.	1 17 6	to 2 4 0
Mixed iron and steel		2 1 6
Heavy cast iron	2 4 0	to 2 5 0
Good machinery		2 7 6
Cleveland—		
Heavy steel	2 2 6	to 2 5 0
Steel turnings		1 11 6
Cast-iron borings		1 2 0
Heavy forge		2 10 0
W.I. piling scrap		2 0 0
Cast-iron scrap	1 19 0	to 2 1 0
Midlands—		
Light cast-iron scrap	1 18 6	to 2 0 0
Heavy wrought iron		2 5 0
Steel turnings, f.o.r.		1 5 6
Scotland—		
Heavy steel		2 1 3
Ordinary cast iron		2 6 0
Engineers' turnings		1 13 0
Cast-iron borings		1 13 6
Wrought-iron piling	2 2 6	to 2 5 0
Heavy machinery		2 10 0

London—Merchants' buying prices, delivered yard.

	£ s. d.
Copper (clean)	30 0 0
Brass	19 0 0
Lead (less usual draft)	10 5 0
Tea lead	8 5 0
Zinc	10 10 0
New aluminium cuttings	72 0 0
Braziery copper	27 0 0
Gunmetal	26 0 0
Hollow pewter	135 0 0
Shaped black pewter	100 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	65/–
Foundry No. 3	62/6
,, at Falkirk	62/3
,, at Glasgow	65/3
Foundry No. 4	61/6
Forge No. 4	61/6
Hematite No. 1, f.o.t.	59/6
Hematite M/Nos., f.o.t.	59/–
N.W. Coast—	
Hem. M/Nos. d/d Glas.	68/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/–
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	62/–
,, No. 3 fdry.	66/–
Northants forge	58/6
,, fdry. No. 3	62/6
,, fdry. No. 1	65/6
Derbyshire forge	62/–
,, fdry. No. 3	66/–
,, fdry. No. 1	69/–
Scotland—	
Foundry No. 1	67/6
,, No. 3	65/–
Hem. M/Nos. d/d	66/–
Sheffield (d/d district)—	
Derby forge	59/6
,, fdry. No. 3	63/6
Lincs forge	59/6
,, fdry. No. 3	63/6
E.C. hematite	73/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	67/–
Staffs fdry. No. 3	67/–
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/–
Dalzell, No. 3 (special)	102/6 to 105/–
Glengarnock, No. 3	80/–
Clyde, No. 3	80/–
Monkland, No. 3	80/–
Summerlee, No. 3	80/–
Eglinton, No. 3	80/–
Gartsherrie, No. 3	80/–
Shotts, No. 3	80/–

FINISHED IRON AND STEEL.

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.)	9 0 0	to 9 15 0
Nut and bolt iron	6 15 0	to 7 10 0
Hoops	10 10 0	to 12 0 0
Marked bars (Staffs) f.o.t.		12 0 0
Gas strip	10 10 0	to 12 0 0
Bolts and nuts, ¾ in. × 4 in.		13 0 0
Steel—		
Plates, ship, etc.	8 15 0	to 8 17 6
Boiler plts.		8 5 0
Chequer plts.		10 7 6
Angles		8 7 6
Tees		9 7 6
Joists		8 15 0
Rounds and squares, 3 in. to 5½ in.		9 7 6
Rounds under 3 in. to ¾ in. (Untested)	6 17 6	& up.
Flats—8 in. wide and over		8 12 6
,, under 8 in. and over 5 in.		8 17 6
Rails, heavy	8 5 0	to 8 10 0
Fishplates		12 0 0
Hoops (Staffs)	9 10 0	& up.
Black sheets, 24g. (4-t. lots)		10 0 0
Galv. cor. shts.	,,	12 10 0
Galv. flat shts.	,,	13 0 0
Galv. fencing wire, 8g. plain		14 0 0
Billets, soft	5 0 0	to 5 12 6
Billets, hard	6 12 6	to 7 2 6
Sheet bars	4 15 0	to 5 5 0
Tin bars		4 15 0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	11d.
Sheet to 10 w.g.	12d.
Wire	12½d.
Rods	11d.
Tubes	15½d.
Castings	13d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	17.34
No. 2 foundry, Valley	16.50
No. 2 foundry, Birm.	13.00
Basic	17.89
Bessemer	18.89
Malleable	18.39
Grey forge	18.39
Ferro-mang. 80%, seaboard	82.00
O.-h. rails, h'y, at mill	40.00
Billets	26.00
Sheet bars	26.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	1.86
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Steel hoops	1.75
Sheets, black, No. 24	2.25
Sheets, galv., No. 24	2.85
Wire nails	2.10
Plain wire	2.10
Barbed wire, galv.	2.60
Tinplates, 100-lb. box	$4.25

COKE (at ovens).

Welsh foundry	19/– to 23/–
,, furnace	15/– to 17/6
Durham and Northumberland—	
,, foundry	21/– to 25/–
,, furnace	13/6
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	17/–
,,	28×20 ,,	34/–
,,	20×10 ,,	24/4
,,	18¾×14 ,,	17/9
C.W.	20×14 ,,	16/–
,,	28×20 ,,	32/6
,,	20×10 ,,	22/9
,,	18¾×14 ,,	16/6

SWEDISH CHARCOAL IRON & STEEL

	£ s. d.	£ s. d.
Pig-iron	£6 0 0	to £7 0 0
Bars-hammered, basis	£16 0 0	to £16 10 0
Bars and nail-rods, rolled, basis	£15 15 0	to £16 0 0
Blooms	£10 0 0	to £12 0 0
Keg steel	£30 0 0	to £31 0 0
Faggot steel	£18 0 0	to £23 0 0
Bars and rods dead soft, st'l	£10 0 0	to £12 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Aug.	17 ..	35	7	6	dec.	12/6
,,	18 ..	36	2	6	inc.	15/-
,,	21 ..	35	12	6	dec.	10/-
,,	22 ..	35	12	6	No change	
,,	23 ..	35	11	3	dec.	1/3

Electrolytic Copper.

		£	s.	d.		
Aug.	17 ..	39	10	0	dec.	15/-
,,	18 ..	40	5	0	inc.	15/-
,,	21 ..	40	5	0	No change	
,,	22 ..	39	15	0	dec.	10/-
,,	23 ..	39	10	0	,,	5/-

Standard Tin (cash).

		£	s.	d.		
Aug.	17 ..	213	5	0	dec.	32/6
,,	18 ..	215	7	6	inc.	42/6
,,	21 ..	213	0	0	dec.	47/6
,,	22 ..	213	2	6	inc.	2/6
,,	23 ..	213	2	6	No change	

Tin (English ingots).

		£	s.	d.		
Aug.	17 ..	214	0	0	dec.	27/6
,,	18 ..	216	0	0	inc.	40/-
,,	21 ..	213	15	0	dec.	45/-
,,	22 ..	213	15	0	No change	
,,	23 ..	213	15	0	,,	,,

Spelter (ordinary).

		£	s.	d.		
Aug.	17 ..	16	12	6	dec.	3/9
,,	18 ..	17	0	0	inc.	7/6
,,	21 ..	16	15	0	dec.	5/-
,,	22 ..	16	16	3	inc.	1/3
,,	23 ..	16	16	3	No change	

Spelter (Electro, 99.9 per cent.).

		£	s.	d.		
Aug.	17 ..	19	0	0	No change	
,,	18 ..	19	5	0	inc.	5/-
,,	21 ..	19	0	0	dec.	5/-
,,	22 ..	19	0	0	No change	
,,	23 ..	19	0	0	,,	,,

Zinc Sheets (English).

		£	s.	d.		
Aug.	17 ..	25	15	0	No change	
,,	18 ..	25	15	0	,,	,,
,,	21 ..	25	15	0	,,	,,
,,	22 ..	25	15	0	,,	,,
,,	23 ..	25	15	0	,,	,,

Lead (English).

		£	s.	d.		
Aug.	17 ..	13	5	0	dec.	5/-
,,	18 ..	13	10	0	inc.	5/-
,,	21 ..	13	10	0	No change	
,,	22 ..	13	5	0	dec.	5/-
,,	23 ..	13	5	0	No change	

AVERAGE MONTHLY PRICES OF UNMARKED BARS (SOUTH STAFFS).

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d	£ s. d.
1899	6 10 0	6 15 0	6 15 0	6 15 0	7 0 0	7 0 0	7 10 0	7 10 0	8 10 0	9 0 0	9 0 0	9 10 0	7 12 11
1900	10 0 0	10 10 0	10 10 0	10 10 0	10 15 0	10 15 0	10 5 0	10 5 0	10 5 0	9 10 0	8 15 0	8 15 0	10 1 3
1901	8 0 0	7 10 0	7 5 0	7 0 0	6 10 0	6 10 0	6 10 0	6 10 0	6 15 0	6 15 0	6 15 0	6 15 0	6 17 11
1902	7 0 0	6 10 0	6 15 0	6 15 0	6 15 0	6 10 0	6 10 0	6 15 0	6 15 0	6 15 0	6 10 0	6 10 0	6 13 4
1903	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 7 0	6 5 0	6 9 4
1904	6 5 0	6 5 0	6 5 0	6 5 0	6 10 0	6 5 0	6 0 0	6 0 0	6 0 0	6 0 0	6 0 0	6 0 0	6 2 11
1905	6 5 0	6 5 0	6 0 0	5 17 6	5 15 0	5 15 0	5 15 0	5 15 0	6 0 0	6 5 0	6 15 0	6 15 0	6 1 10½
1906	7 0 0	7 5 0	7 5 0	7 5 0	6 17 6	6 15 0	6 12 6	6 10 0	6 10 0	6 12 6	6 16 3	7 3 9	6 17 8½
1907	7 3 9	7 5 0	7 5 0	7 5 0	7 5 0	7 7 6	7 5 0	7 7 6	7 7 6	7 7 6	7 7 6	7 5 0	7 5 11
1908	7 2 6	7 0 0	7 0 0	7 0 0	6 15 0	6 7 6	6 5 0	6 2 6	6 2 6	6 2 6	6 2 6	6 0 0	6 10 0
1909	6 0 0	6 0 0	6 0 0	5 17 6	6 0 0	6 0 0	6 0 0	5 17 6	6 0 0	6 2 6	6 2 6	5 17 6	5 19 9½
1910	6 2 6	6 3 4½	6 7 6	6 7 6	6 7 6	6 7 6	6 6 6	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 7
1911	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 10 0	6 12 6	6 16 6	6 7 0
1912	6 18 9	7 1 10	7 2 6	7 8 9	7 18 0	8 0 7	8 2 6	8 3 6	8 5 0	8 6 3	8 7 6	8 8 9	7 17 0
1913	8 11 6	8 10 7½	8 10 0	8 8 1½	8 2 0	8 0 0	7 17 6	7 11 6	7 8 9	7 5 6	6 18 1½	6 17 6	7 16 9
1914	6 17 6	6 15 7½	6 12 6	6 10 0	6 10 0	6 10 0	6 10 0	7 11 10½	8 0 0	7 12 6	7 5 7½	7 6 3	7 1 0
1915	7 11 6	8 5 11	8 8 9	9 6 0	10 3 2	10 19 2	11 12 6	11 13 1½	11 13 9	11 14 3	12 1 10½	13 0 9	10 6 0
1916	13 7 6	13 10 8	13 12 9½	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 8 9½
1917	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0
1918	13 15 0	13 17 3	13 17 6	13 17 6	13 17 6	13 17 6	13 17 6	14 15 0	14 15 0	14 15 0	14 15 0	14 15 0	14 4 5½
1919	15 10 0	16 5 0	17 15 0	17 15 0	20 15 0	21 0 0	21 0 0	22 0 0	22 0 0	22 0 0	22 7 6	22 12 6	20 1 8
1920	24 7 6	24 10 0	25 10 0	27 10 0	29 5 0	31 0 0	31 10 0	31 10 0	31 10 0	31 10 0	31 10 0	29 7 6	29 1 8
1921	26 17 3	25 0 0	23 0 0	21 0 0	19 0 0	18 5 0	16 0 0	16 0 0	15 14 0	14 0 0	13 6 8	13 0 0	19 4 5
1922	13 0 0	12 3 9	11 14 0	11 11 10½	11 5 0	11 3 6	11 2 6	11 5 0	10 17 2½	10 16 3	10 12 0	10 12 6	11 7 0½
1923	10 16 10½	11 3 1½	12 2 6	12 8 9	12 11 6	12 1 3	11 15 11½	11 15 0	11 15 0	11 15 0	12 13 6	12 8 3	11 18 10½
1924	12 9 6	12 10 0	12 10 0	12 15 7½	12 17 6	12 17 6	12 17 6	12 17 6	12 17 6	12 14 0	12 12 6	12 12 6	12 14 3½
1925	12 12 6	12 12 6	12 12 6	12 12 6	12 12 6	12 7 6	12 7 6	12 7 6	12 4 6	11 18 6	11 13 9	11 13 0	12 6 2½
1926	11 7 9½	11 5 0	11 5 0	11 5 0	11 3 9	11 3 9	11 5 0	12 0 0	13 0 0	*	15 7 6	12 19 0	12 0 2
1927	12 6 3	12 2 6	11 14 0	11 0 0	10 18 9	10 13 6	10 12 6	10 5 0	9 16 0	9 15 0	9 13 9	9 12 9	10 14 2
1928	9 12 6	9 12 6	9 11 0	9 10 0	9 8 4	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 3 6	9 1 3	9 7 0
1929	9 0 0	9 2 6	9 5 7½	9 9 4½	9 10 0	9 17 6	10 2 6	10 2 6	10 2 6	10 0 6	10 3 9	10 5 7	9 15 2½
1930	10 7 6	10 7 6	10 7 6	10 6 10½	10 6 3	10 5 0	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6	10 4 7½
1931	10 2 6	10 0 0	10 0 0	10 0 0	9 18 1½	9 17 6	9 17 6	9 17 6	9 17 6	9 17 6	9 17 6	9 16 10½	9 18 0½
1932	9 15 0	9 15 0	9 15 0	9 15 0	9 13 9	9 11 3	9 10 0	9 10 0	9 10 0	9 6 3	9 5 0	9 5 0	9 10 11½
1933	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	—	—	—	—	—	—

* No quotation available owing to strike.

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